JOURNAL *of* FORESTRY

May

1935

Vol. XXXIII Number 5

SOCIETY OF AMERICAN FORESTERS 1900

Published by the
SOCIETY of AMERICAN FORESTERS

Single Copy Sixty Five Cents   Four Dollars per Year

JOURNAL of FORESTRY

OFFICIAL ORGAN OF THE SOCIETY OF AMERICAN FORESTERS
A professional journal devoted to all branches of forestry

Entered as second-class matter at the post-office at Washington, D. C.

Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Section 412, P. L. and R. authorized November 10, 1927.

Office of Publication, Room 810, Hill Bldg., 839 17th St., N. W., Washington, D. C.

Editorial Office, Room 810, Hill Bldg., 839 17th St., N. W., Washington, D. C.—Manuscripts intended for publication should be sent to Society's headquarters, at this address, or to any member of the Editorial Staff. Closing date for copy, fifth of month preceding date of issue.

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CONTENTS

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EDITORIAL

THE CHANGING BASES OF PUBLIC FOREST POLICY

PUBLIC forest policies are not the handiwork of foresters. They spring from deep popular convictions regarding forest use and forest services. Leadership, accident, and the pressure of special interests, private or sectional, largely decide when and how well these convictions are translated into policies; many political forces are in constant interplay, and the will of the people is often like a sleeping giant, inert until aroused. But in the long run, what is generally and strongly believed to be required for the public welfare controls. Public forest policy in the United States represents, in the large, the gradual unfolding of a national purpose, based on firmly held convictions.

Very soon after the nineteenth century opened, fears of an approaching timber shortage and protests against forest destruction began to be increasingly voiced. When, after the Civil War, the lumber industry expanded into its modern form and began to operate far in advance of the demand of settlers for cleared land, the chorus of protest swelled. The first response was laws to encourage forest planting. Five states and territories enacted such laws in the sixties, and eleven more followed in the seventies. In 1872 New York began to look into the expediency of a forest preserve in the Adirondacks. In 1873 the American Association for the Advancement of Science began to memorialize Congress and state legislatures on "the importance of promoting the cultivation of timber and the preservation of forests." This bore as its first fruit the 1876 federal provision for forestry work in the Department of Agriculture. In 1877 Carl Schurz, as Secretary of the Interior, recommended the reservation and administration of all the public domain timberlands.

The prairie settlers wanted, in their new and bare surroundings, the comfort and adornment of trees and woods, such as they had lived amongst before their westward migration. Most of those who were active elsewhere on behalf of forest preservation, lacking acquaintaince with conservative forestry practices, thought tree planting the way to obtain new stands. The existing forests they seemed to regard as doomed. As early as 1864 George P. Marsh's Man and Nature, later revised and republished under a new title, The Earth as Modified by Human Action, had acquainted Americans with the scientific thought of Europe on the consequences of forest destruction. This epochal work confirmed popular observation on the value of a forest cover; and very sweeping generalizations became accepted current thought. That the rise

and fall of nations was intimately related to forest abuse and destruction, through profound climatic alteration as well as through accelerated erosion, streamflow changes, and destructive floods, was soon taken as axiomatic.

Equally exaggerated and ill grounded ideas prevailed as to the imminence of timber exhaustion. In 1883 a widely quoted statement was made by Professor Sargent that the merchantable white pine left in the United States "does not today greatly, if at all, exceed 80 billion feet, and this estimate includes the small and inferior trees, which a few years ago, would not have been considered worth cutting." Complete exhaustion of this supply was predicted in about eight years; and "with the exception of the narrow redwood belt of the California Coast, no North American forest can yield in quantity any substitute for it." A *New York Evening Post* editorial said that "at the present rate the people of the United States will, in less than 20 years, not only depend for the necessary supply of timber to cover their current wants entirely upon foreign countries, but our country will be almost completely stripped of its forests." A pamphlet published in the same month declared that the northern mills "could in twelve months' time convert the whole merchantable pine of the State of Georgia into lumber, and be but six months in using up the pine of Florida."

The *New York Evening Post* editorial dealt also with the question of forest influences. The consequences of such deforestation as was threatened, (it said,) every well informed person knows—dried-up springs, destructive floods at one season of the year, dry river-beds at another, parched fields, once fertile plains turned into deserts. "We can see the lesson illustrated in Spain and in the ruined countries of Asia. This will be our inevitable fate unless the suicidal course we are now pursuing be stopped."

Books could be filled with similar citations. New York, in initiating in this country public forest administration through its law of 1885, was swayed primarily by fears that lumbering in the Adirondacks would disastrously affect both navigation and climate. There was anxiety regarding the Hudson as well as the Erie Canal; and anxiety lest diminished rainfall and desiccating winds should ruin farming. Governor Flower, in 1892, warned the legislature of the probability that, without forest preservation, New York might suffer "the long periods of drought and uncertain rainfalls in some of the treeless states of the West." Colorado, on entering the Union in 1876, memorialized Congress on the vital necessity, for her industries and her agriculture, of measures to safeguard her mountain forests against destruction and to afforest the plains for climatic improvement. And so the story goes.

Deep popular convictions are not easily altered. The country has continued to believe that public policies of forestry are demanded to safeguard water supplies, hold erosion in check, and meet future timber requirements. These convictions have never wavered, though they no longer run to such extremes as those of sixty years ago. Nevertheless, profound changes in the motivation of the forestry movement took place during the decade when Theodore Roosevelt and Gifford Pinchot stood in the forefront of its leadership.

Those leaders of thirty years ago saw a country threatened with monopolization of its great natural resources through the spread of private ownership and the consolidation of that ownership, wherever it could be made profitable, in the grasp of big business. They saw also the threat of rapid and wasteful exploitation

under the impulse solely of the desire to pile up greater profits. The control of the economic life of the country by a relatively small group, largely superior to and in control of the political government, was to be fought against. So was the sapping of that economic life by the weakening or removal of its foundations. The issue directly involved was in the first case social, in the second economic; but the grand objective in both cases was to head America towards a political, social, and economic order in which the power of concentrated wealth to control business and run it for piling up greater wealth under the same control should be curbed in favor of economic independence for the small man—the square deal, in other words—and in which the future as well as the present welfare of the country should be safeguarded. To this last was given the name of national efficiency.

The Spanish War and the annexation of the Philippines had suddenly made the United States a great world power. Men envisaged a country of two hundred million souls by the midcentury, and ultimately of hundreds of millions more. Malthusian pressure upon land resources as the final limit of population growth was taken for granted. To husband these resources with care lest they be exhausted prematurely, and to fight against their becoming private monopolies lest they create insufferable inequalities, were held essentials both for national health and national strength, in a world in which only the most powerful nations would be able to hold their own. These were the basic tenets of the conservation movement which Theodore Roosevelt headed.

How profound the change since then! We are confronted with the strange economic paradox of idle land, idle labor, and idle capital—the three elements of production each of which is supposed automatically to constitute a demand for the other two. Instead of an approaching Malthusian pressure upon the natural resources of the country, we seem to be faced with the practical certainty of a population near its peak and shortly to begin a decline. Instead of a European demand for the products of agriculture limited only by our capacity to produce in excess of our own needs, our farmers are compelled to seek the rearing of tariff walls against imports from abroad. Instead of monopolies based on centralized private ownership of our great fundamental resources, we are confronted with the three-horned dilemma of controlling at one and the same time destructive competition, wasteful exploitation, and ever-increasing concentration of wealth and economic power based on legal devices and financial and marketing organization. The dream of a rejuvenated America to be brought about by building up a citizenship of free and independent small-scale producers and entrepeneurs—the ideal of the Theodore Roosevelt "square deal" and the Wilsonian "new freedom"—has turned out to be as insubstantial as have been all dreams of a return to the "golden age", since the world began. For better or for worse, the clock of time runs forward, not backward.

The basic matter today in forest policy is how to find ways of putting a vast area of lands not in demand for agriculture to as effective use as possible for the employment of surplus labor, the sustained production of commodities, the maintenance of permanent communities, and the rendering of other valuable economic and social services. Changing ways of life and newly recognized requirements for outdoor recreational facilities have built up a new and important demand for forest policies that will suitably meet this form of public need; and erosion control is fast coming to be seen as one of the greatest resource problems of the nation. To these bases our forest policies are undergoing adjustment.

FORESTRY—A PUBLIC AND PRIVATE RESPONSIBILITY[1]

By F. A. SILCOX

Chief of the U. S. Forest Service

In this address the Chief Forester clarifies and amplifies his views, as set forth at the annual meeting of the Society and reported in the March issue of the JOURNAL, regarding the circumstances that might make desirable government logging from its own lands, and possibly in rare instances small-scale milling operations. Code administration and the federal forest land acquisition policy are also commented upon. Sustained-yield management of the timber-producing forests of the country is the fundamental necessary social objective. Private industrial management should be continued wherever it can render the social services necessary at a cost no greater than that which public operations would impose.

I WELCOME this opportunity to meet with you. It is, I feel, fortunate and fitting that you and I should seek counsel together. For in forests and forest lands we have mutual interests, responsibilities, and opportunities. And properly to understand and redeem them, there must be clearness and frankness as to viewpoints, objectives, and methods of approach. It is in that spirit that I am here.

You either are, or you represent, timber operators and owners. As such, your interests are linked with forests and forest lands. So are mine. For, specifically charged with that responsibility, I represent the public. And as your interests extend beyond forest lands in your own ownership, so do the public's interests extend far beyond the areas which are today in public ownership. They are, as a matter of fact, vested in all forest lands, yours included; in an empire that constitutes almost one-third the total land area of the continental United States.

For many decades a virile, resourceful lumber industry has operated in, and profited from, a resource which nature provided. In the process, towns and communities were established. The industry was founded and financed on a basis of quick liquidation. On that basis, and with what seemed like inexhaustible supplies in sight, forest lands were exploited, forest industries moved from one forest region to the next. Then the inevitable happened;—towns were left stranded and forlorn, local agriculture and labor were bereft of local markets, community indebtedness was defaulted, the social and economic structure was devastated.

SOME INDUSTRIAL READJUSTMENTS NECESSARY

Events of the last few years have clearly shown the need for some readjustment in our industrial and economic structure. The nature of these readjustments will require careful and unprejudiced thinking of all of us. It is but natural that at a time like this there should be many divergent opinions. In a democracy like ours these opinions may be reconciled through free and frank discussion by those whose interests may be affected. Both the lumber industry and the public are vitally concerned in finding a realistic solution of the forest problems which confront them.

Public opinion recognizes that old methods and results are unnecessarily wasteful. It is conscious of the fact that forests are not deposits of ore, they are, rather, products of the soil susceptible, like other crops, of renewal and management in accordance with well known sciences and practices, and that they can be managed so that they will contribute

[1]Address delivered before the National Control Committee of the Lumber Code Authority at New Orleans, La., March 13, 1935.

support to a fair share of our nation's population with some degree of security and stability.

In frankness I must say, however, that as far as I can see, after travelling widely over this country, a large portion of the lumber industry is still operating on the basis of quick liquidation, draining off the few remaining reservoirs of virgin timber with the usual inevitable result. There are notable exceptions to this general statement, but, unfortunately, the exceptions are all too few.

I am convinced that the progressive leaders of the industry realize fully this situation, and sincerely want to see their industry change from a suicidal to a sustained yield basis. It is in the interest of the industry from every standpoint that this be done at the earliest possible time. It means, now and in the long run, greater security to the investments made, a more stable market for the manufactured product, a wider tax base at lower rates, a greater degree of security and stability to communities and, by no means the least to be considered, a restoration of public confidence which will insure, as nothing else can, a sympathetic understanding and consideration of the difficult problems which have beset the industry and are, in a major degree, still besetting it.

I want here not merely to state the general situation as I see it from a public point of view. I want sincerely, with your coöperative help, to find out why a course of action, recognized by both public and private interests as desirable, is not being made effective more rapidly, and what is necessary to be done to bring the change about.

Private Enterprise Should Not Be Superseded or Abridged Without Evident Reason

At the outset, let me say that in my opinion there is no social advantage in substituting public management of industry if private initiative can and will accomplish the same social objectives at no greater cost to the public. It is only when private initiative fails to meet the needs of the people that the government must step in to protect the public interests. The entire forest program of the federal government is based upon this principle.

For some thirty years the Forest Service has pointed out the need for a change in the methods employed by the lumber industry in dealing with its timber properties. But as long as virgin stands of timber remained to be cut, and the industry made money, little attention was paid to any real practice of forestry. Then came the industrial collapse of 1929, and the necessity of the government to step into the breach, with its credit and other resources, to prevent chaos.

To meet an emergency situation which is all too fresh in our minds to need any elaboration here, there was set up by the government a number of devices, admittedly experimental. Among these there was the National Industrial Recovery Act, under which industry was to work out its problems with governmental assistance. The lumber industry was, to its credit, one of the first to undertake compliance with the terms of the act, and draft for itself a code.

Only those of you who went through the process, giving generously of your time and money, know the complications and difficulties involved in setting up rules of conduct and standards,—or a code,—for an industry so highly decentralized and so robust in its pioneering vigor and individualistic enterprise. It is to your credit that, despite all the difficulties, the job of drafting and securing the acceptance of a code for the industry was accomplished.

The Lumber Code, approved August 19, 1933, has naturally very much in common with the whole series of codes

designed to secure fair competition, and approved for all major industries. Dealing as it did, however, with one of the major basic resources of the country, there was included in the Code a unique provision: viz., one on conservation. It is primarily in connection with this provision of the Code that the Forest Service has the most direct responsibility.

Under Article X of the Code, acting for the Secretary of Agriculture, the Forest Service has coöperated with the industry to draft a program of public and private action necessary to make effective the conservation provisions of the Code. After a series of conferences, the industry made a number of definite commitments, including its approval of minimum woods practice rules, its agreement to observe and enforce them, its recognition,—through a reward in the form of allocations of additional production—of the necessity for the practice of sustained yield if the intent of its commitments under Article X are to be fulfilled.

The record is clear that the industry made these committments on Article X contingent on public assistance to help carry them out and, no doubt, with an understanding that provisions of the Code, other than Article X, would be enforceable as a part of the general program. In fairness, there can be no question about this.

Code Administration Difficulties

Now, after a little over eighteen months of Code operation, there is a sense of confusion and frustration growing out of the delays in securing compliance with the basic Code requirements on prices, volume allocation, and hours and wage standards. Changes in the original price provisions have been made, growing out of conflicts of opinion within the industry, and in a change of policy regarding such measures on the part of the public. The volume allocation provisions are having a difficult time, because of the low volume of business which has been available to carry the overhead and operating costs on existing mill capacity. Wage and hour provisions are being disregarded by many small operators, who, finding no real enforcement, proceed to go their own way irrespective of the Code provisions. With these difficulties, and in part because of them, is the confusion about the present and future legal status of the N.R.A.

I do not want to discount these difficulties, nor do I minimize the serious, far reaching effects that such uncertainty has on making effective the provisions of Article X, which has been in effect since last June. The conservation provisions of the Code are in no vacuum; they are an integral part of the Code itself. How soon the legal status of N.R.A. will be determined—well, your guess is as good as mine. There is no doubt, however, that the policy underlying the whole question of the codes, and their enforcement, will be determined in the not too distant future. As you well know, cases which will at least indicate, if not determine, how far the federal government can go in making terms of the codes effective are now pending before the Supreme Court.

I realize that until such determinations are made there will be an inevitable tendency for certain groups to cast off all restraint; to start again the toboggan slide which even the bitterest critics of the Code will, I believe, admit were stopped for a time, at least. But despite all of the perplexities, the difficulties of enforcement, the legal confusion, and the uncertainties of the future, I am not pessimistic about the result. The procedure set up under the Code is one which offers the opportunity to sit around the table to discuss and deal in a flexible, democratic manner with the problems of industry. I for one would regret to see frozen into legislation provisions which should be left flexible within a broad,

liberally legal structure. Because for the first time in the history of the world a whole nation has made an effort to settle its major industrial problems within the limits of a democratic structure. And whatever the future holds, I have faith that we are going to preserve, if we are wise, that method of dealing with our national problems. The procedure set up under the codes, therefore, it seems to me, offers the only opportunity to coöperatively work out our problems in a manner which insures the representation of all interests vitally concerned. I have been unable to find any alternative which holds promise of safeguarding our democratic institutions and at the same time coming to grips with the real problems which confront us and making progress in their solution.

Public Coöperation With the Industry Has Been Substantial

Pending the time that legal decisions are made, and the future becomes clearer, action can be taken by the public agencies, the industry, and both in combination, to do certain clearly defined things. Out of the joint conferences there was evolved a program of action. On the one side, the industry definitely commits itself to stop the process of cut-out and get-out and go on a sustained yield basis, in return for which the public will give aid by building up and maintaining, coöperatively, an adequate fire protective system; aid in protection from insects and disease; relief from present inequitable systems of taxation; extension of credits; promotion of research work, and the acquisition of large areas in public ownership, both of cut-over lands and reserve supplies of timber.

Both the lumber industry and the public agencies have been moving toward the carrying out of this plan of action. You have set up your organization with foresters on the job to check up, to educate, and to explore fully the possibilities of making effective improved forest practices. I am sure you will continue those efforts. The public, on the other hand, has, nothwithstanding the fact that no major legislation has been introduced or passed concerning the items of the public program, taken definite steps to carry out its part of the program. I'll not catalog a long group of statistics, but suffice it to say that already nearly $2,-000,000 of federal money is expended with the state in coöperation with private owners. This has been tremendously supplemented by the work of the C.C.C. camps, which last year did fire protective work on privately owned lands which, if paid for by such owners, would have, it is estimated, cost over $75,000,000; the emergency funds have made possible the purchase of very nearly 8,000,000 acres of national forest land; the R.F.C. has extended credits to some 134 lumber concerns; the President has sent a letter to governors of all states urging each of them to call together representatives of federal, state and private industry to consider the tax delinquency of timber lands, and other forestry questions.

The public has already taken extensive action to assist the industry, but the industry, with few exceptions, has not taken seriously a readjustment of itself to get on a sustained yield basis but has, instead, been inclined to take the position that the public should be satisfied with bare minimum woods practice requirements. The leaving of areas productive is essential and desirable, but it does not get at the heart of the problem, which is to so manage these timber properties, including the remaining stands of virgin timber, that there will be no gap in production, with resulting community collapse, during the period that the young stands are reaching merchantable size.

The Federal Acquisition Policy and Plans

In carrying out the public's part of the program there is one particular question

in which I know you are all interested: What is the policy of the federal government in the purchase of timberlands? This question arises from the fact that within recent years the government has entered upon an expanded forest acquisition program. This policy has been the gradual outgrowth of a real need for the government to take part in safeguarding the remaining forests of the public domain and reclaiming cut-over lands which private initiative could not, or would not, restore to productivity.

This policy is one of long standing. During Cleveland's administration, when it became evident that the nation's timber supplies were rapidly dwindling as a result of cutting and fires, the government withdrew a portion of the forested public domain from entry and set it aside to remain as public forests. This policy was later expanded, particularly by Theodore Roosevelt, during whose administration most of the national forests in the West were established. Later, when it became evident that millions of acres of cut-over land in the East were not being reclaimed by the private owners, a popular demand arose that the government should take over this land and restore it to productivity.

Thus there came to pass the Weeks Law, followed by the Clark-McNary law, which with their amendments opened the way for government acquisition of forest areas as national forests. A few of the states, and in some instances counties, have followed a similar policy of blocking out some of the state public lands, or lands reverting for non-payment of taxes, into state or county forests. The lumber industry has generally supported this policy of public acquisition, because of the realization that the owners of the land would not restore it to productive use and thus assure a future supply of raw material for the wood-using industries.

It is for the purpose of building up permanent communities or preventing communities from becoming stranded after cutting out of the timber that the government has recently modified its forest acquisition policy. In the past, as you know, we were concerned mainly with assuring timber supplies to meet future needs. We bought chiefly cut-over land or timberland of low present value. Such land will afford opportunity for large-scale employment only in the more or less distant future. At the same time the accessible timberlands were gradually being cut out, and the communities dependent on them were finding themselves without means of livelihood. For this reason the government has recently undertaken to acquire some of the mature timber in sections of the country threatened with such early timber exhaustion as jeopardizes the existence of local communities. The idea is that the government, by buying strategic tracts in the midst of privately owned timber lands, cannot only help to stabilize the lumber industry in the region but also use such areas as demonstration forests.

These public lands will be managed on a permanent sustained yield basis. They cannot, however, be expected to maintain mill capacity on the present basis. Neither can private lands be expected to maintain present mill capacity; nor the two together. In combination, however, on a sustained yield basis, such adjustment as must be made will be less drastic and the foundation can be laid for permanent communities, though small in size. This is the minimum which the public, in its self interest, must require; the one to which the industry must adjust itself. The present acquisition policy of the Forest Service, therefore, cannot be considered as aiming at competition with private owners. On the contrary, its whole purpose is to strengthen the economic structure of the regions involved and to assure the industry, and the com-

munities dependent upon it, a permanent existence.

To accomplish this the Forest Service has definitely in mind to plan its purchases after careful and thorough study and consultation with the state agencies and private owners regarding the possibilities of creating sustained yield units capable of supporting forest industry communities. The aim, of course, is to insure that each owner within such a unit shall take full responsibility for maintaining his land in a state of high productivity. It should be a truly coöperative undertaking, with a common goal but with individual responsibility for the respective holdings. In such an undertaking, however, it would be impractical for the government to undertake management of too small blocks. This statement of policy refers particularly to purchase of timberlands other than those purchased primarily for watershed protection or purposes other than timber production.

Supplementing the federal acquisition program there should be acquisition by the states of similar but possibly smaller and more widely distributed areas. These, also, should be handled on a sustained yield basis. The management of these areas should be coördinated with that of federal and private lands. I believe it would be wise public policy to encourage the states to acquire such areas, even to the extent of extending federal assistance. So much for the policy of acquisition.

Another question in which I know you are most vitally interested is competition from government logging or milling.

Conditions Under Which Public Logging Might Be Justifiable

The government is faced, as you know, with a very real and immediate problem of providing useful work to millions of its citizens. This is a task from which we cannot shrink, and which we must face realistically. Where a community on or close to public forests is in need of employment, and where there is a local demand for forest products and private initiative is lacking or unwilling to undertake logging, the government would be justified, in my opinion, in logging its own timber as a means of providing immediate work and supplying local needs. This is not essentially different from present day contract logging as practiced by the lumber companies, except that the initiative would come from the government and the work would be under closer supervision.

There is much to be said for this type of logging on public forests. The government is charged with the responsibility of managing its forests on a sustained yield basis and with the utmost regard for improving conditions of growth and for protection against fire and disease. This can sometimes be accomplished much more readily by selling logs, cut and removed from the woods under the immediate supervision of forest officers, than by selling stumpage. No matter what provisions may be included in contracts for sale of stumpage, it is not always possible to make the contracts sufficiently flexible to cover all the silvicultural measures that are required in order to leave the forest in the best growing condition. We have had considerable experience, for instance, with slash disposal in connection with logging on the national forests. It is the general opinion both of the operators and of the Forest Service that the best way to do an effective job of slash disposal is for the government itself to do it. This applies with equal force to the felling and skidding of trees so as to avoid damage to young growth. If the government sells logs instead of stumpage it has greater latitude in determining the amount cut per acre so as to meet silvicultural requirements.

By logging its own timber the government can utilize bug-killed or fire-killed

timber which may have only a limited market and which private operators are unwilling to take. The government can generally afford to take out such material even at a slight loss, because of the benefit to the forest. Insect control in the West often costs more than $4 per M feet of trees treated. A few dollars additional spent on logging would frequently salvage all or most of the timber that now has to be destroyed. Similarly, government logging may be necessary to salvage timber killed by fire and other causes. Until we are able systematically to remove the major portion of this dying or dead timber from the forest we must expect occasional conflagrations to destroy both public and private timber. We cannot expect private industry to undertake the job everywhere in the public forests.

Government logging of its own timber, even if carried on fairly extensively, will not offer serious competition to private enterprise. Less than 5 per cent of all the logs cut now come from the national forests. Most of the sawmills operating on national forest timber would be just as well off if they purchased the logs instead of the standing timber. Sawmills operating on their own timber would not be affected by government logging, because it is not the intention of the Forest Service to force more logs or lumber on the market than can readily be absorbed.

I would not recommend government logging in inaccesisble regions where construction of costly railroads and other improvements would be required. Under such conditions selective logging and sustained yield management might not be practical, and such operations would be even less justifiable on public than on private forests. But as the public forests become more fully equipped with permanent roads, the delivery of logs at mills or at the roadside, where they may be sold to the highest bidder, should become a common practice, just as is done in many countries today. Government logging of its own timber in a manner most advantageous to the future growth of the forest is as logical as the harvesting of his crop by a farmer.

As to saw-milling or other manufacturing, justification for government operations can be found only in exceptional cases. The Forest Service does not propose to embark on competition with the lumber industry, which in general is already too much over-equipped with plant capacity, although much of it is badly located with respect to sustained yield operation, is obsolete, or is of too crude design for economic production. The Forest Service prefers to assist private industry in retiring surplus plants and in gradually substituting plants in forested areas directly related to sustained yield capacity.

Where Public Milling May Be Advantageous

It would, however, be to the advantage of the lumber industry for the government to install a few small mills on an experimental basis in various regions for the purpose of testing and demonstrating better methods of milling and utilization. It is well known that throughout the eastern forest regions utilization of inferior portions of stands has hardly anywhere been successfully solved. The systematic removal of these trees, usually in partial cuttings, is necessary if better and more productive growing stock is to be gradually built up. It is unlikely that private enterprise can afford to undertake the necessary experimental work in this field. It is very desirable for the Forest Service to do it in a few localities, largely with labor which would otherwise be unemployed and on government relief.

In some instances it is in the public interest for the government to produce its own lumber, where this cannot be

obtained readily or at reasonable cost from other sources. The construction of dams remote from railroads but close to public forests, construction of buildings connected with forest administration, and similar construction where the sawmill forms an essential part of the equipment of a large public engineering enterprise, are cases in point. In order to salvage fire-killed or bug-killed timber that cannot be handled advantageously by existing sawmills, the government may have to convert it into lumber or other forest products.

Such governmental activities should always be dictated by public necessity. Cases such as those mentioned are, I am sure, rare. If the industry meets its responsibilities to the public by furnishing needed materials at reasonable prices and by helping, as it is being helped, to stabilize employment and community life, the need for government logging and timber conversion will not arise.

The Field for Private Management Very Large

No matter how extensive the public forestry program may be, it is utterly impossible that all of the forest land will be brought into public ownership. The boldest estimate of public acquisition that has been made leaves approximately half of all the commercial forest land in private ownership. At present, four-fifths of the entire commercial forest land is privately owned, and the responsibility for managing these lands so that they insure security and stability of communities dependent upon them thus rests mainly on the private owners.

The policy which the Forest Service should follow, it seems to me, is perfectly plain. Besides building up the public forests it must aid and encourage private forest management. All unreasonable obstacles to successful private forestry should be removed. States and local governments must eventually, in their own interest, make sure that their timberland tax is spread over a large area, with reasonable and moderate valuations at low rates, thus giving the industry a chance to practice sustained yield and to guarantee to the local governments a continuous source of income, instead of increasing taxes on a constantly narrowing base with high rates. This is a vicious circle through which both the timberland owner and the local government lose. This current land tax can be supplemented with a deferred tax on yield when the ripe timber is cut.

With the lumber industry recognizing its social responsibilities, there is no reason why the whole question of taxation should not be reconsidered in the interest of making private forest practice more assured. The attitude of the local governments, in the past, was a direct outgrowth of the actions of the industry itself. Instead of treating the forests as a permanent, renewable resource, the forest was used as a mine which was exhausted and abandoned with little or no consideration for the social and economic consequences to dependent communities. This resulted in hundreds of so-called ghost towns—abandoned by their inhabitants after their investments in homes and other property had been wiped out—and in stranded populations supported largely by public subsidies. Many counties and townships in the cut-over sections of the country receive state subsidies in order that they may carry on governmental services that are greatly in excess of their own contributions to the state treasuries. It was but natural that the local communities and governmental taxation agencies insisted on taking all the traffic would bear while the taking was good. With a change of methods on the part of the industry, I am sure that local taxation agencies will see that it is to their own advantage to make timberland taxation reasonable.

It is to the credit of the lumber indus-

try that it has realized the need for a change in the handling of its lands and has voluntarily undertaken, under Article X of its Code, to kep forest land permanently productive with sustained yield as the eventual goal. I realize that there has not yet been sufficient time to test the efficacy of self-imposed forest regulation by the industry, and I further realize that old habits and pioneer psychology can be changed only gradually, that the mistakes of the past cannot be repaired overnight. Yet the placing of the lumber industry on a permanent basis must not be postponed too long. The industry should not wait until the government has smoothed out all of the difficulties in the path toward sustained yield management. It is essential to the welfare of the industry itself to abandon its policy of quick liquidation and disregard for the social consequences. The industry should seek, of its own accord, to prevent the construction of new plants in excess of the normal productivity of the tributary forests, and should seek to transfer the existing excess capacity to other localities where the normal production of the forests is not being utilized.

The present set-up of the N.R.A., with a deputy administrator for forest conservation and the Forest Service as a technical and inspection agency, should insure more speedy progress and should be of immediate benefit to the industry itself, as well as a guarantee to the public that forest production will be made permanent in the future. The proposed amendment which would bring under the Code all minor forest industries, together with the contemplated division of responsibility for large and small operators, respectively, between the industry and the Forest Service, should do away with many difficulties that have hindered the enforcement of the Lumber Code.

In brief, the Forest Service, through its own activities on the national forests, and through coöperation with private owners and forest industries, strives toward sustained yield management of both public and private forests. I can best express this objective in the words of Schedule C of the Lumber Code itself: "To provide without interruption or substantial reduction raw material for industry and community support."

To this, our common end, I invite and earnestly desire your coöperation.

FOREST DISEASE CONTROL IN NEW ENGLAND

The New England Section of the Society of American Foresters has among its standing committees one on forest disease control. The article which follows is the progress report of the committee for the year 1934. It briefly outlines the situation with respect to a number of the tree diseases of the region.

AS INDICATED in our reports for the past two years, the Civilian Conservation Corps work has opened a field in forest pathology which previously received rather scant attention. This was because other problems were more urgent and because there was so little real forest improvement work done that there seemed to be no way to influence practical management after the results were obtained.

Nectria Diseases

The Nectria and Strumella cankers are examples of such problems, which, with the new turn in affairs, became of primary importance. The Nectrias have been the object of investigation both north and south. The beech-Coccus-Nectria complex has been studied in Canada several years with funds from the National Research Council of Canada, the territorial government of Nova Scotia, and Harvard University, while the University of West Virginia has carried on investigations of the Nectria canker of black walnut and other hardwoods. Both have materially increased our knowledge, but necessarily have left to be answered many questions raised by the C.C.C. work. The Division of Forest Pathology is supervising the use of Emergency Conservation Work funds getting answers to some of these urgent Nectria problems. This work has been under way only 18 months, but considerable definite information is already available, with promise of more as the work is continued. A large mass of data is in hand and is being worked up as rapidly as possible. The following is a very brief statement of results in New England to date.

Nectrias are so generally present in northern hardwood stands that in most localities it is impractical to attempt the removal of all cankered trees, but the ideal of the silviculturist should be to eliminate diseased trees in all weeding, thinning, or improvement operations *unless there is some very strong silvicultural reason for retaining certain cankered trees.* Even then, it must be remembered that trees with trunk cankers or many branch cankers are likely to be short lived and too much dependence ought not to be placed upon them for any long term silvicultural effect.

In the Northeast there are several different Nectrias which are associated with cankers of the hardwoods. Practically all hardwood species are attacked occasionally, some much more frequently than others. Heavily cankered stands occur in scattered patches, the surrounding forest often having but a few cankered trees widely separated from one another. Sometimes nearly all hardwood species within a diseased area are heavily attacked, and sometimes but one or two species. The frequency of cankered trees of a given species within a certain area should be an important factor in deciding what species should be discriminated against in that area. For instance, in an area where red maple and sweet birch are heavily cankered while only a few trees of other species are attacked, one should discriminate against the red maple and sweet birch and retain other species. In an area where all hardwoods are frequently cankered, one can only retain

the uncankered or lightly cankered hardwoods of the best silvicultural species, or change from hardwood to softwood stand by favoring what softwoods may be on the ground and planting with suitable softwoods to fill blank spaces.

Cross inoculations show that the Northeastern Nectrias are not closely limited to certain hardwoods; that is, they will go rather indiscriminately from one species to another. However, certain tree species are resistant or are able to fight off attacks even after small cankers are started. On the other hand, there are some tree species which are apt to be heavily cankered in most disease areas. Such species are yellow birch, mountain maple, sweet birch, red maple. It is definitely known that weed species of hardwoods may be important as sources of infection for their more valuable neighbors. This makes more urgent the usual silvicultural rule to eliminate so far as possible these weed species, because they are not only useless but actually dangerous. Such species are mountain maple, striped maple, red maple; and beech and some other species in certain localities where they are heavily cankered. Where the felled cankered trees must be left in the woods, experiments to date indicate that any method of disposing of the felled trees is about equally effective; i.e., no one method can be recommended strongly over the others.

Moisture favors fruiting activity of the Nectrias, while drought inhibits it. This indicates that thinning and weeding operations should aid in slowing down the progress of the Nectrias and may even decrease the number of new cankers which can form, as these operations must tend to reduce the moisture among the trees somewhat according to the degree that the stand is opened. Again, the stimulation of growth of the trees left standing should aid them to fight off attacks by the Nectrias, as these fungi are generally believed to thrive in trees which are not making maximum growth. In dense young stands there are many instances where trees or branches rub against each other. Such wounds are favorable places for the Nectrias to start cankers. This emphasizes the need for the usual silvicultural practice of removing such trees.

It has been learned that beech is naturally attacked by a number of different Nectrias. It is susceptible to nearly all that have been inoculated onto it. It is a dangerous element in a stand of northern hardwoods. The prejudice of foresters against beech because of its usual high cull from decay appears to be fully justified by this relationship with the Nectrias, and also because of the beech-Coccus-Nectria disease in Maine and the Canadian maritime provinces, and the local dying of beech from adverse weather conditions in the western Adirondacks and farther west. Beech usually cannot be considered a first-class tree silviculturally.[1]

Stereum Diseases

Another group of diseases of both soft and hardwoods which has come to attention in connection with the C.C.C. work is caused by species of Stereum. Work on the rots of sprout oak stands has shown that a white-mottled rot of living trees of various oaks is caused by *Stereum gausapatum* Fries. It is a rather

[1]Ashcroft, J. M. European canker of black walnut and other trees. W. Va. Agr. Exp. Sta. Bull. 261: 1-52. 1934.

Ehrlich, John. The beech bark disease: a Nectria disease of Fagus, following Cryptococcus fagi (Baer). Can. Jour. Research 10: 593-692. 1934.

Welch, D. S. The range and importance of Nectria canker on hardwoods in the Northeast. Jour. of For. 32: 997-1002. 1934.

common rot fungus in sprout stands in the oak type as far south as North Carolina. Extensive culture work with the wood rotting fungi now being carried on at Washington, D. C., by the Division of Forest Pathology, has revealed the identity of the fungus, the rot of which has been known for years. It is not unlikely that other species of Stereum will be definitely connected with small-pocket rots of oak, but they have been less frequently encountered in our studies to date. These rots usually enter from the old stump, but sometimes through a dead sprout. After reaching the heartwood of the living trees they appear to spread rather rapidly up and down. Studies are under way which it is hoped will result in definite recommendations as to best ways of treating sprout groups to reduce decay to a minimum.

The conifers are attacked by another species of Stereum, *S. sanguinolentum* Alb. & Schw., throughout the north temperate zone. It has been known for years as a saprophyte on stored pulpwood and on dead slash and dead branches on living conifers. About 10 years ago it was found in Sweden seriously damaging living Norway spruces which had been blazed and marked for felling but were left standing one or two years before cutting. This fungus entered the blaze marks and rotted a length of 2 meters in less than 2 years. Still more recently it was found to be the cause of the "sapin rouge," hemlock heart or red heart of living balsam firs in Canada. In our own studies of balsam fir rots it has been found causing considerable loss in Maine, New Hampshire, and New York. It is reported to attack living alpine fir in Idaho also. But it has lately been found attacking pruning wounds of northern white pine where large living branches were cut experimentally. It infected wounds 4 to 6 inches across in which the heartwood was too large for the exuding pitch to cover and protect it. Within 2 years' time it entered such wounds, formed fruiting bodies, and entered the living trunk of the tree for some distance. It has all the characteristics of a very serious factor in pruning of living branches. It makes more imperative the pruning of trees before the living branches attain a diameter of more than 1½ inches. Where dangerously large branches must be severed the wounds may be protected with a coating of Bordeaux paint made by mixing equal parts by weight of dry commercial Bordeaux and raw linseed oil.[2]

Pine Leaf Cast

A serious leaf cast of red pines has been known for several years in nurseries in Massachusetts. It probably occurs in other places without being recognized by the nurseryman. Specimens of the fungus have been determined as *Lophodermium pinastri* (Fries) Chev. It is usually first noticed in October after heavy frosts, when the needles become a dull green or purplish-red in color, and appear dry. The next spring, small dead spots form and the diseased needles die back from the tips. Small black dots develop on the dead parts. These are fruits (pycnidia) in which characteristic tiny spores are borne. A little later elliptical black bodies about 1/16 inch

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[2]Davidson, R. W. *Stereum gausapatum*, cause of heart rot of oak. Phytopath., 24 (7): 831-832. 1934.

Spaulding, Perley, MacAloney, H. J., and Cline, A. C. *Stereum sanguinolentum*, a dangerous fungus in pruning wounds on northern white pine. U. S. Dept. Agr., Northeastern For. Exp. Sta. Technical Note 19: 1-3. 1935. (Mimeographed).

Division of Forest Pathology, Bureau of Plant Industry. Memorandum to E. C. W. officers. Supplementary information on forest tree diseases in relation to stand improvement. pp. 3. 1935. (Mimeographed).

long form on both sides of the needles. They bear spores in tiny sacks (ascospores), which are shot into the air when ripe and are thus borne by wind currents to neighboring pines, where they may start new infection. The diseased needles fall prematurely, thus weakening and often killing the young plants. Entire one-year beds have been killed. In transplants the loss may be 10 to 50 per cent. The fungus occurs in the forests on practically all species of pines, but is commonly found on older trees, which are not severely injured. The younger the tree which is attacked, the more deadly is the disease. Suitable spraying with double strength Bordeaux mixture or lime sulphur is said to have controlled it in nurseries in northern Europe and in Massachusetts. The first application should be made when the new leaves are about half grown. It should be followed by a second in 3 to 4 weeks, and a third when the seasonal growth is made, where there have been bad outbreaks in previous years.[3]

Dying of Beech

Quite extensive dying of beech of all ages has occurred in the western Adirondacks. It was distributed in patches of considerable extent from the Tupper Lake basin westward as far as Gouverneur and northward to the vicinity of Potsdam. The available evidence indicates that it is due to the combined effects of drought from June to October in 1933 and the exceptionally severe winter of 1933-1934.[4]

A New Red Pine Canker Disease

A new canker disease of red or Norway pine has recently been found in plantations established from 1916 to 1919 in southern Connecticut. Its appearance is apparently closely correlated with the severe drought in that section in 1930. Damage is incurred from the weakening effect of the parasite, from breakage of the stem at the canker, and from the entrance of staining and rotting fungi through the open cankers. The disease is being thoroughly investigated by the Division of Forest Pathology.

Dutch Elm Disease

The symptoms of this disease may first appear in early June. The leaves wilt on the young twigs, retaining the green color if the wilting is sudden but often turning yellow or brown. Often the twig itself wilts and forms a peculiar shepherd's crook at the drooping tip. Wilted twigs or branches may be scattered, or in extreme cases the entire crown may be affected. The large dead leaves soon fall, but partially developed ones at the tip of the wilted twig remain. A diagonal cut through a diseased twig shows brown discoloration in the sapwood. Other diseases cause wilting and discoloration of leaves, and even brown discoloration in the wood. This makes it difficult to diagnose the trouble. Cultures must be grown before one can be certain that the fungus is *Ceratostomella* (*Graphium*) *ulmi* (Schwarz) Buisman.

From the standpoint of the public the situation with the Dutch elm disease is good, since the danger is becoming fairly well and generally known. This is shown by the additional money which has been appropriated for removing the known diseased trees. But it should be realized that complete eradication of this disease and the saving of the elm will mean the sacrifice of some apparently healthy elms on the outskirts of the dis-

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[3]Spaulding, Perley. *Lophodermium pinastri* causing leaf cast of Norway pine in nurseries. U. S. Dept. Agr., Northeastern Forest Exp. Sta. Technical Note 18: 1-3. 1935. (Mimeographed).

[4]Spaulding, Perley and Hansbrough, J. R. The dying of beech in 1934. U. S. Dept. Agr., Northeastern For. Exp. Sta., Technical Note 20: 1-3. 1935. (Mimeographed).

eased areas. Unless power is given to thoroughly clean up an area, especially on the outer edges, success is greatly handicapped and made much more expensive in the long run.

From the scientific standpoint, the situation is unsatisfactory. The disease can be carried by a native insect as well as the imported one. There is an uncertain number of fungi which attack elm and cause symptoms of disease like those of this imported blight. They are in groups which are especially difficult to identify with certainty, and much time and study will be required to make clear their several life histories and relationships to the imported disease. Such investigations are being carried on, and certainly should continue until the fate of the elm is definitely known.

Such control as is possible has been and is now urgently recommended. Too much is at stake to permit slackening of the control in the slightest degree. It may be impossible to eradicate it, but this is not definitely known yet, and until that time comes there can not be any shirking of the job, disagreeable as it may be. This has been a time of all kinds of emergencies. This disease merits that designation if any tree disease ever did. The public should not be needlessly alarmed, but it should fully realize that the elm is in a very precarious situation. An aroused public opinion, intelligently directed, can make or break the work of control of this ominous devastator.[5]

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[5]May, C. Outbreaks of the Dutch elm disease in the United States. U. S. Dept. Agr. Circular 322: 1-19. 1934.

Clinton, G. P. and McCormick, F. A. The Dutch elm disease, *Graphium ulmi*, in Connecticut. Science (n.s.) 81 (2090): 68-70. 1935.

FUNGUS CONTROL AS ONE MEANS OF SAFEGUARDING FUTURE MARKETS FOR WOOD

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The problem of maintaining stable and sufficiently large markets for wood has become of increasing significance in recent years. One phase of the problem is the control of fungus deteriorating agents, which attack lumber, logs, and other wood products in storage and in use. Such agents are an important factor in increasing manufacturing costs, reducing quality and utility value, and developing unwarranted prejudices against wood products. Resulting losses and inconvenience to both the consumer and manufacturer are often far greater than is indicated by the value of the material affected. In the following discussion an analysis is made of some of the damage and its effect on present and future markets for wood. Present accomplishments in developing feasible control methods and the need for further progress is mentioned for some of the most important problems.

WHEN full allowance is made for the value of forests in watershed protection and for recreation, it is still true that a part of our timber land must justify itself as an investment by an ultimate cash return. This requires not only a satisfactory yield but a satisfactory market for the products. The role of a proper knowledge of the pathology of forest products in helping to insure such markets is the subject of this discussion.

For the past twenty-five years there has been a declining trend in the per capita consumption of wood products. To some extent this decline has been the result of the development of more stable communities and industries. Considering competitive products, it was inevitable that some would replace wood for uses in which relative cost and utility value were to their advantage. It is generally recognized, however, that some of the substitution could have been avoided if a proper appreciation of the needs and potentialities of improved wood products had existed. While substitute materials have been modified and improved in an effort to satisfy the requirements of an exacting market, the lumber manufacturing and wood-using industries have not taken full advantage of the possibilities of their raw material. The feeling of security in regard to markets based on the assumption that wood was indispensable for many uses was partly at fault. With continued apathy it is not impossible that the full realization of the value of the forest investment will be hampered by a shortage of suitable and sufficiently extensive markets.

The fact that a comprehensive program of research is part of the answer to a stable forest industry is now more or less generally recognized by the industry. The Forest Products Laboratory has, of course, accomplished much, and industry has increased its participation in such activities in latter years. The aims of such research are to (1) improve manufacturing methods looking to lower costs and a higher quality product, (2) insure efficient utilization and thereby the fullest satisfaction to the consumer, and (3) develop new uses. It is with the first two of these, although to some extent with the third also, that a proper knowledge of the deteriorating agents in wood and the factors affecting them can be of most help in maintaining stable markets for wood.

An analysis of some of the damage caused by wood deteriorating agents and its relation to present and future markets for wood will be of interest. Consider first decay—which is second only to fire

in aggregate damage, increases manufacturing costs, shortens the period of usefulness, and develops unwarranted prejudices against wood. The consequences of decay to both the consumer and the producer are far greater than the value of the material destroyed would indicate. To the producer it has meant increased handling and manufacturing costs, or in other words an added handicap in meeting price competition with substitute materials.

As specific examples, decay in stored logs has been estimated to involve from 3 to as high as 50 per cent of the merchantable volume of the log and to represent a minimum annual bill in the entire United States of millions of dollars. Decay in this case is not confined to the log, but continues in the green lumber placed in air seasoning piles and is a potential menace to uninfected lumber coming in contact with it. Similar decay in lumber, poles, and other products during seasoning and storage are further sources of loss. Production costs are thereby increased and lumber is hampered in price competition with substitutes.

To the consumer the replacement costs, inconvenience, and element of risk and uncertainty involved in decay are far more important than the value of the actual wood needed for replacement. The consequence, so far as wood markets are concerned, is that further use of wood may be avoided. The introduction of rotted material into buildings and the subsequent infection of lumber in place has been one of the major problems along this line. While serious decay cases in buildings occur only sporadically, their spectacular nature causes them to receive undue attention, with the result that whole communities may be prejudiced. Recurrences of decay add to the difficulty, as may be easily realized in the case of a school building in Texas in which two replacements of a floor were necessary within several years.

A number of factors are operating to keep such losses high, and possibly to increase them. In the first place, an increasing proportion of sapwood and of the less durable woods is being used in construction, with the passing of virgin timber stands. Changes in architectural design are tending to reduce ventilation beneath and within homes and to place more wood close to or in contact with the ground. The increased use of humidifiers has probably been a factor in decay in sills and sashes. The use of low quality and unseasoned lumber by speculative builders has come into the picture in recent years. Little or no advancement has been made in the way of protecting dry lumber from rain after delivery on the job. Unless the construction is such that wet lumber will dry in place, this produces a chance for decay to become established in the building. Incipient decay originating from improper log and lumber storage continues to be a factor in subsequent infections in buildings. Finally, treated lumber still remains unavailable to most wood users in the cheap and ready quantities necessary for widespread use.

Decay in wooden members of automobile bodies has likewise been the cause of considerable loss and some danger to life, particularly in the southern regions. Some of the woods employed in auto bodies are not durable, and if used untreated it is not surprising that decay occurs. Anyone who has had this experience with his car knows how costly and inconvenient it can be. In Florida it is said that the condition of the top, whether sound or decayed, is a large element in the resale value of the car. The conspicuousness of a decayed top makes it a rolling advertisement of unsatisfactory service from wood, and has been the source of considerable prejudice.

Wood framing is considered a desirable feature of good body construction from the standpoint of such qualities as resiliency, prevention of rumble, and freedom from rattles. Jeopardizing such a market in any way where the cause is preventable ought certainly to be avoided. Efficient preservative treatments, several of which are already in use, would add little to the cost of the car and might do much toward holding this market.

Sap-stains and molds are entirely distinct from decay. They have been an important factor in increasing the costs and lowering the quality of wood products. The costs of such mill practices as end-racking, steaming, and dipping of lumber are partly or wholly chargeable to stain. Extra stock segregations are required, adding further costs to the mill and retail yard. One of the most important results is that the objectionable appearance of discolored stock has produced a psychological reaction tending to decrease sales even for uses in which the stained stock is fully as good as the unstained.

This prejudice has increased in recent years, as reflected in the more rigid grading rules as to the amount of stain permitted even in common lumber. Foreign buyers particularly have objected to stained material, and have either been allowed large claims or have shifted their purchases to less susceptible woods. This increasing prejudice, coupled with the fact that the stain problem will become more acute in second-growth timber because of its large proportion of susceptible sapwood, has made the problem of control an increasingly important one. While stain has no great effect on many of the strength properties of wood, it reduces its usefulness where a natural finish is desired. Buyers commonly link decay with stain, and to some extent this is justified, since blue stain is frequently accompanied by decay and may mask it. Both types of deterioration are promoted by the same environmental conditions.

Considerable progress has been made, and now should be made, in meeting some of the aforementioned problems. While some of the present losses are unavoidable within the limits of practicability, a large part are preventable through the use of improved methods, some of which involve little additional expense and only slight changes in current practices. Notable success has been achieved through wood preservatives, in some cases serviceable life having been increased as much as ten times. While preservation is a wood conservation measure, it has resulted in satisfactory service and therefore has been a factor in the continued use of wood. As regards different woods, the tendency produced by wood preservation has been to increase the use of the less durable and reduce that of the more durable species.

Whether the accomplishments of preservative treatments have resulted in a greater or reduced consumption of wood as a whole is a matter of some conjecture. So long as supplies of such species of desired durability and mechanical properties as white oak, larch, cedar, and chestnut were available in sufficient and cheap quantities for tie, pole, piling, and similar purposes, wood had less to fear than at present from competitive materials. However, even these woods are not considered good enough by most discriminating users of today to employ without treatment. Consider the possible result, therefore, had it been necessary to expose untreated pine, gum, and other less durable species to the severe decay conditions encountered in such uses. The steel tie, to which the attention of the country was being directed in the nineties as a means of delaying the expected famine in durable woods, would certainly have come into the field if the preservation industry had not developed. There-

is still need for improvement in wood preservation, and particularly in extending most effectively its use to building construction material.

In the case of building decay, studies of the organisms concerned and factors affecting them have yielded information of value in control attempts. Examination of actual cases in the field has indicated that slight modifications in construction and design, simple safeguards in most instances, would have reduced the danger to a negligible point. The common faults lie in providing insufficient ventilation beneath and within buildings and in placing untreated wood under conditions favoring the absorption and retention of moisture. However, a proper evaluation of the different factors concerned has not been made, with the result that we are not yet able to issue recommendations for entirely safe practices without making them too complicated and expensive. What is needed is an extensive survey of decay cases in the field, followed by the development of simple control measures which can be easily applied by architects, builders, and the consumer. Another phase demanding further consideration is the control of infections already established. That work along these lines has possibilities is shown in a decay case in roofs of oil storage tanks in Louisiana. Control was made possible in this instance by the recommendation of steaming the tanks at specified intervals.

Considering sap-stain, the development of efficient treatments of low cost and easy application has aided both pine and hardwood manufacturers in improving quality and lowering costs of their products. It has stimulated an interest in stain control, and hence in a generally improved product wherever these deteriorating agents occur. These treatments also give promise of reducing incipient decay infections during seasoning, which, if true, would be of value to the consumer as well as the manufacturer and retail dealer. A necessary further step in stain control is the extension of the use of treatments to small mill production. Small mills are becoming increasingly important, particularly in the South, where during 1929 over 6 billion feet, or more than 50 per cent of the cut, came from such production units. The efforts of the larger mills to raise the quality and reputation of the products of their industry are handicapped considerably if a large proportion of the production does not fall within the standards set by them. Different conditions of use are encountered in adjusting stain control measures to small mill application, but indications are that such treatments will be practicable.

Similar treatments to those used in stain control give promise of accomplishing efficient control of fungus deterioration of stored logs. Recommendations can already be made for the South as to the prevention of stain and decay during normal log storage seasons, when insects, such as the ambrosia beetles, are inactive. Attempts have been made to develop suitable pre-treatments for the control of stain and decay in ties, poles, and posts during seasoning prior to impregnation. While promising results have been obtained in some instances, the treatments tried have not been sufficiently consistent in effectiveness to justify recommendation. Work on pre-treatments and on the problem of log storage during periods of insect activity is being continued on a small scale. The adoption of recommendations that can already be made on storage, sanitation, and chemical treatment practices in the handling of lumber and logs will serve materially to reduce present losses.

It might be stated at this point that a cure-all chemical treatment has not been and probably never will be de-

veloped. A number of requisites other than toxicity must be satisfied by a practical treatment, and these will vary with the conditions of use. Considering toxicity alone, it is obvious from the work on lumber and logs that differences in the fungus species encountered and their reaction to poisonous materials may influence materially the effectiveness of any given treatment. In addition the chemical variations within different wood species must be considered. It is for the above reasons, together with the influence of environmental factors in the field, that laboratory toxicity and durability tests are only indicators of practical value at best, and must be supplemented by field trials.

The need for reliable methods of detecting decay and its effect on mechanical properties of wood has been apparent. The failure to differentiate properly between different fungus defects has caused needless rejection in some cases and injudicious selection for use in others. In the selection of wood for airplane stock, for instance, difficulty was caused at one time by the inclusion of material infected by certain fungi which produce no noticeable change in color or density of the wood in the incipient stages. In this case, selection of the material should have been made in the woods, where the presence or absence of decay in the tree could have been determined more easily. On the other hand, needless rejection of Douglas fir has followed the mistaking of highly colored normal heartwood for the similarly colored incipient stages of certain types of decay.

Fungi vary considerably in the manner and extent to which their attack is reflected in changes in the mechanical properties of wood. With some species, principally those producing brown crumbly rots, serious losses in strength and toughness occur before there is very perceptible softening or any conspicuous change in the appearance of the wood. With others, principally the pocket-forming types, relatively little loss in strength may be evident with considerable change in physical properties and appearance of the wood. The relation of decay to the mechanical properties of wood has been studied for several fungi. Thus, relative strength tests of pecky cypress and the important red heart in pine and other conifers, the latter caused by *Fomes* (*Trametes*) *pini*, have shown that infected wood is usable for many purposes. With *Polyporus schweinitzii*, on the other hand, which causes a brown root and butt rot of conifers, the incipient stages of decay are reflected in such pronounced strength reductions that the wood is rendered valueless for most uses. Tests of sap-stained material have shown that except for uses where discoloration alone is objectionable stained wood is practically as suitable as the unstained. There is a need for further improvement in methods of distinguishing important discolorations from unimportant ones.

Durability studies in the field particularly, but to some extent in the laboratory also, have been of value in indicating proper uses for different woods and in determining the effects of different practices on the decay-resisting qualities of wood. The results of a recent laboratory study of the relative durability of steamed and unsteamed sap gum may be of interest in this latter respect. Steaming has been in wide use among southern hardwood manufacturers as a means of reducing stain occurrence and facilitating rapid seasoning. The practice as followed by some operators has been under suspicion of lowering durability of the unseasoned material, and certain wood users have discriminated against such treated stock. The study completed recently indicates that the suspicion may be justified in some cases,

since the unseasoned steamed wood decayed at a more rapid rate than the unsteamed. Whether this condition held true for the air-seasoned steamed stock as well was not determined. The present indications, at least, are that steaming is hazardous unless properly done, and particularly unless good air-drying practices follow its use.

As new developments occur in the wood industry, new pathological problems present themselves. With the expansion of the wood pulp and paper industry, the problem of the deterioration of stored pulpwood and pulp was encountered. Studies conducted by the Forest Products Laboratory on methods of storage and the use of chemical treatments have helped the industry to meet these problems. Other studies on the pulping qualities of rotted wood have shown that some fungi are destructive to yield and quality of pulp, whereas others have a relatively small effect except in the final stages of decay. Continued study of the fungi concerned and their effects on wood should result in fewer losses and insure higher quality pulp. With the development of composition boards of one type or another, it was found necessary to provide for decay control if the product was to be used under conditions which at any time were conducive to fungus growth. This problem has been partly met by the use of toxic substances. A new field, and one not properly pathological, is that of the use of wood-inhabiting organisms for the production of chemicals from wood. The harnessing of some of these forms to serve useful purposes is quite a different role from their usual one of destructiveness.

The trends of research on the pathology of forest products in other countries may be of interest as possible indicators of the future investigative course in the United States. Such trends are related to the importance of the forest and its products in the economic life of the country. In Germany, for instance, where the normal needs are as great as or greater than domestic supplies, the emphasis of research has been placed on problems directed at securing the efficient utilization, or in other words the maximum utility, of the wood. The same condition holds true for other wood importing countries, as Great Britain, France, and Denmark. Thus in the field of products pathology we find considerable work done on the control of decay through improved construction and design and through the use of efficient preservatives. Laboratory toxicity studies in which new and promising chemicals and combinations of chemicals are tested against wood-destroying fungi constitute one of the major specific fields of work. Such a trend in research in these countries is to be expected, since there would be no consistency in permitting preventable waste of the product in use and at the same time practice intensive utilization in the forest, even to twigs and bark. Incidentally, work of the type just mentioned is also an aid to wood exporting nations in insuring satisfactory service from the products of their forests.

In such countries of wood surpluses as Sweden, Finland, and Russia, where economic development depends more or less on stable wood markets, research efforts in products pathology are more specifically in the direction of aiding the retention and expansion of markets in competition with not only other materials but also other woods. Emphasis is placed on improved practices designed to lower manufacturing costs and thereby meet price competition, and on increased quality and modification of the product designed to satisfy the preferences of an exacting market. Much work is therefore done on sap-stain and mold control and on the prevention of deterioration of

stored log and manufactured products.

As to the United States, it would seem that attempts at securing efficient utilization must go hand in hand with those of lowering costs and raising quality. While world markets may absorb any future surpluses of our forests, this is no established fact, and it is the ultimate as well as the initial cost and satisfaction which will play a part in the permanence of markets within the United States. Specific present problems with which the pathologist can render material assistance are the control of decay in buildings and the prevention of sap-stain, mold, and decay in stored logs, lumber, and other wood products. New problems will probably be encountered with the appearance of new modifications and uses for wood. The development of simple, efficient methods of meeting these problems followed by an educational campaign directed at their adoption is a step towards safeguarding future markets for wood.

FROM a conversation with my grandfather, Herman Haupt, an engineer well acquainted in Pennsylvania, I derived the following facts:

At the time when the re-organization of the forestry work in the Department of Agriculture was under consideration the suggestion was made from quarters that I am not familiar with that what was needed to head this department was a trained forester. Abram S. Hewitt, a very well known public man in Pennsylvania, had this question brought to his attention and at once said that he knew of a man who filled the bill; namely, Dr. B. E. Fernow. Hewitt's acquaintance with Fernow probably arose from Fernow's work as a private or consulting forester with certain companies owning timber lands in Pennsylvania. It was upon Hewitt's recommendation that Dr. B. E. Fernow was appointed as chief of the Division of Forestry, on the basis of his technical knowledge of forestry.

I regret that I have not more explicit information as to the details, but the above is absolutely authentic.—H. H. Chapman.

THE BALSAM WOOLLY APHID IN THE NORTHEAST

By H. J. MacALONEY[1]

Northeastern Forest Experiment Station

The balsam woolly aphid is well established throughout the range of balsam fir in New England. No control measures applicable to large areas are at present known; and where balsam fir forms an appreciable part of the stand, severe infestations will greatly reduce the value of the crop.

IN RECENT years the balsam woolly aphid, or fir bark louse, *Adelges* (Dreyfusia) *piceaa* Ratz., has been very prevalent in Maine, New Brunswick, and Nova Scotia, and has been considered as the chief cause of the widespread mortality of balsam fir in these regions. It is of European origin, although apparently it has been established in North America for some time. Peirson and Gillespie (3) state that during the past three years it has been found in 34 townships scattered over the southern half of Maine; while Balch (1) reports that the whole of Nova Scotia is infested, that material has been received from Prince Edward Island, and that the approximate northern limit in Canada runs from Shediac to Fredericton, along the St. John River to Rosborough, and down to the border at Vanceboro, Me. Swaine (4) reported it in Nova Scotia in 1929, and Balch states that it has been there for over 20 years. Kotinsky (2) reported that in 1916 he had seen specimens from Mount Monadnock, N. H., where trees had been killed by the insect, and that he had determined material collected by Hopkins at Brunswick, Me., in 1908 as the same species.

Because of numerous reports of the presence of this insect in a few widely scattered localities in New Hampshire and Vermont during 1933, it was considered advisable to make an extensive survey during the field season of 1934 to ascertain the extent and severity of the infestation in these states, and it was also decided that portions of Massachusetts and New York should be examined. In addition to this extensive survey, plans were made to lay out permanent sample plots for future examination and study, and semipermanent (or temporary) sample plots in order that some information might be obtained on the general condition of the stands, as well as of the trees themselves, and the severity of the infestation in different forest types.

The life history of the balsam woolly aphid in Canada has been studied by Balch (1). Inasmuch as forest conditions in the northeastern part of the United States approximate closely those in the eastern part of Canada where Balch did his work, it did not seem necessary to duplicate this study. Balch, and also Peirson and Gillespie, have experimented successfully with spray materials for ornamental trees, but no control measures applicable to forested areas have been developed.

Generally speaking the balsam woolly aphid is present wherever balsam fir is found in New Hampshire and Vermont. In Massachusetts, infestations were found in natural stands in the Berkshire Hills as far south as Becket, and in addition dead or heavily infested ornamental trees were found in four localities almost directly south of Mount Monadnock, N. H., the farthest south being at Petersham. In Maine the author and other representatives of the Bureau of Entomology and

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Plant Quarantine have found infestations in 60 townships, increasing considerably the number reported by Peirson and Gillespie (3). Early in September, 1934, Mr. H. K. Henry, of the Conservation Department of New York, discovered an infestation in a 50-year-old plantation in the township of Oppenheim, north of the Mohawk River and approximately 80 miles from the nearest known infestation on the western slopes of the Green Mountains in Vermont. There is little doubt in the writer's mind that a careful survey will disclose infested areas in the Adirondack Mountains, although not connected with the widespread dying of balsam fir in this region for the past two years that has been caused by some agency not specifically determined at this time. The accompanying map shows the extent of the general infestation, and also the locations of infestations farthest north, west, and south.

Apparently, as Balch has stated, all sizes and ages of balsam fir are liable to attack, and infestations have been found on all kinds of sites, including sour sphagnum bogs where the growth is very slow, in almost pure stands, and also in mixtures on well-drained soils where the balsam appeared to be vigorous. Altitude may have served to check the spread in some degree, although infestations have been found at an elevation of 2,550 feet on Bartlett Haystack Mountain, in New Hampshire, and at an elevation of 2,750 feet near Mount Stratton, in Vermont.

An infestation on the trunk or branches looks very much like that of the common pine bark aphid. The insects may be so numerous as to cause the bark to appear white all over the bole and larger branches. When the twigs are attacked, the insect causes gouty swellings of the nodes and buds, and on the young seedlings the twigs are killed, often resulting in death of the seedlings themselves. On older trees, particularly where the infestation is of long standing, the crowns may become distorted and flattened owing to the death of the twigs, and in many cases the upper bole will show an abnormal taper. Balch has also observed this. Both trunk and twig infestations have been found in nearly every infested area, although previously it had been thought that the gouty form was most common near the coast and might not be found to any extent inland. Even in the infested area at Oppenheim, New York, the gouty swellings were present generally.

The severe infestations found during the course of the survey were not near the western Maine boundary, as had been expected, but south and west of the Mount Monadnock region. Ornamental balsam firs surrounding a cemetery at Royalston, Mass., approximately 20 miles south of Monadnock, have been dying for at least five years, according to the cemetery caretaker. One dead tree, still standing, has an extremely gouty condition at the top. It would appear that the original infestation began some years previous to the first death. At Kelley's Stand, on the western slopes of the Green Mountains in Vermont, about 10 miles from Mount Stratton, the heaviest infestation was found. The condition of this stand indicates that the insect has been present for at least 10 years. Both trunk and twig infestations are very common, and some of the dead trees have been down so long and have deteriorated to such an extent that it is impossible to tell when they actually died. This area also is the largest known infestation, at least 25 acres being practically ruined.

It is very apparent that a heavy stem attack, either on the upper or lower bole, will cause the death of a tree in a relatively few years. Increment borings were taken from both dead and living trees in four permanent sample plots in New Hampshire, and a study of the annual rings shows a rather remarkable accelera-

tion of growth on heavily infested trees for two years before death. This is not very noticeable on lightly infested trees, and is entirely lacking on trees free from attack. There is also a tendency toward pressure wood, or "rotholz," in the affected trees that is not found in the unaffected trees.

Various insects and wood-rotting fungi are associated with the attack of this aphid, and some of them may play an important part in the deterioration of the dead trees. The most numerous insects are: *Pissodes dubius* Rand., *Monochamus mormorator* Kgy. and *M. scutellatus* Say, *Pityokteines sparsus* Lec., *Serropalpus barbatus* Schall., *Xylotrechus undulatus* Say, *Phymatodes dimidiatus* Kby., and the rather common carpenter and *Camponotus herculeanus* L. The common wood rots of balsam fir were present in many of the trees that were dead. In some cases the writer is of the opinion that *Armillaria mellea* Fries (Quelet) may have aided in the killing of the trees.

As a result of the survey it can be definitely stated that the balsam woolly aphid is established throughout New England where balsam fir is found. The infested areas in Massachusetts and in southern New Hampshire and Vermont represent, for the most part, infestations of longer standing than those in the northern parts of Vermont and New Hampshire. It would appear that the original infestation was that reported by Kotinsky in 1916 on Mount Monadnock, and that the insect has gradually worked its way northward. Balsam fir does not, as a rule, form a very important part of the stand in the southern end of the infested area. Perhaps this is why no great notice has been taken of the dying trees over a period of years, such as would be the case in the more northern part, where the species often forms more

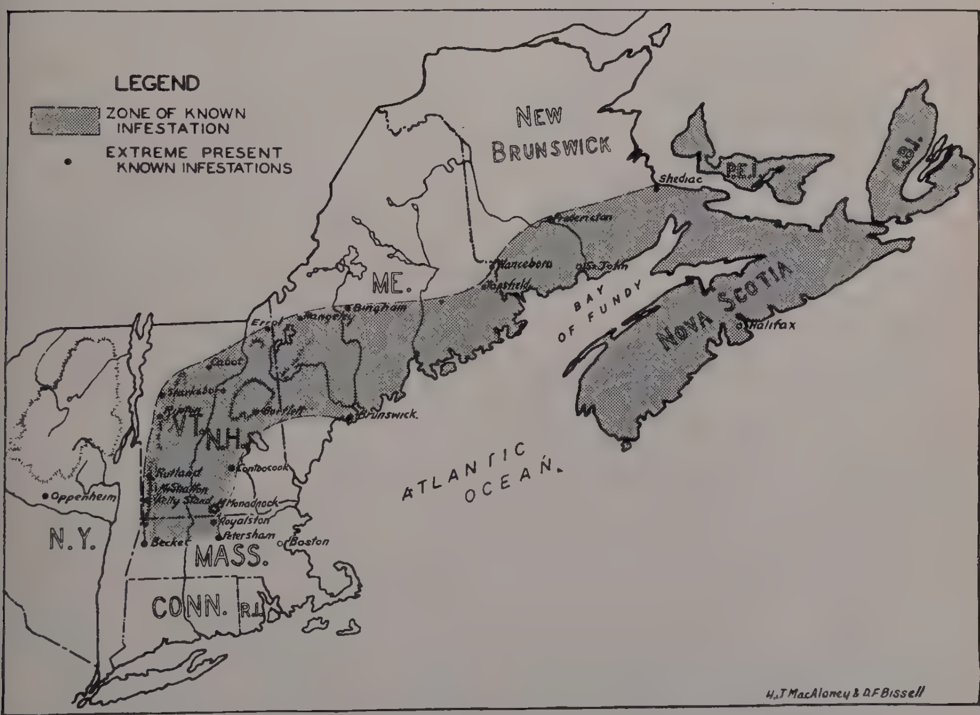

Fig. 1.—Extent of general infestation of the balsam woolly aphid in northeastern North America.

than 50 per cent of the stand. The infestation along the coast of Maine has probably been there for many years, and may be traced to the older one found by Hopkins in 1908.

It may not be amiss at this time to suggest a possible explanation as to how the older infestations may have been checked. The winter of 1933-34 has been recorded as the coldest in the history of the Weather Bureau in New England, and it is known that a great percentage of the overwintering form occurring above the snow line died because of the intense cold. The winters of 1917-18 and 1919-20 have also been recorded as severe, January, 1918, having been listed as the coldest month on record until February, 1934. It is the writer's opinion that these severe winters also caused a heavy mortality, checking the infestation to such an extent that approximately 10 years passed before it was again sufficiently heavy to kill many trees. Doctor Craighead has suggested to the writer that some of the dying fir he observed in Canada in 1920-23 may have been caused by this insect rather than by the spruce budworm.

Control of the insect in forested areas will be difficult, if not altogether impossible. Sanitation operations, involving the removal of infested trees, are useless after the trees die, as the aphids die then, also. In clearing out infested living trees, stumps and roots would have to be removed, as there is considerable infestation on the exposed roots and about the root collar and on the butt swell in the moss that collects there. There would be no necessity for removing the dead trees unless the trees could be utilized. In a forested area control by spraying is not practical, but plans are being made, in cooperation with the Melrose Highlands Laboratory, to spray a group of badly infested trees, leaving some near-by infested trees as a check, in order to determine whether or not the trees will die if the aphid is controlled. If successful, such a method would be applicable to ornamental balsam.

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A DISEASE OF CONIFERS CAUSED BY *STEREUM SANGUINOLENTUM*

By ERNEST E. HUBERT

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It has long been known that *Stereum sanguinolentum* causes an important rot of coniferous trees. Dr. Hubert presents circumstantial evidence which indicates that the fungus under certain conditions may become parasitic and cause the death of coniferous trees.

IN THE spring of 1930 about 90 of the eighteen to twenty year old planted Douglas fir trees (*Pseudotsuga taxifolia*) growing in a dense pure stand near Moscow, Idaho, showed evident signs of disorder, and suddenly died. A number of true firs (*Abies grandis*), some spruce (*Picea excelsia*), several white pines (*Pinus strobus*), (*Pinus monticola*), and several (50) European larch (*Larix europea*), all growing in pure stands, were later found dead or dying under very similar circumstances. Previous to and during 1930 a shortage of rainfall affected the trees in this region, but no evidence of the effects of drought was noted until the foliage of these trees turned red and the trees died.

While drought was at first believed to be responsible for the death of these trees, it was later discovered that another agency played an important part. In 1931 a few more conifers were added to the death list; and in 1932, due to the copious rains and snowfall, it was thought that the trees would show no further signs of disease. The symptoms were only delayed, however, and in the latter part of June and in early July additional Douglas firs, one or two red pines, and several white pines were added to the rapidly mounting numbers of dead or dying trees.

On July 19, 1932, a study was begun on 122 dead and dying Norway spruce transplants which were transplanted in 1928. These young trees, 7 to 8 years old, died rapidly on the approach of warm weather, and the signs clearly indicated a disorder of the roots and root crown, in many ways resembling the disease found on the older trees. Further study revealed no signs of the mottled bark disease, and the disorder was classified as chlorosis of physiological origin.

McCallum (3) decribes a disease of *Abies balsamea* which causes very serious damage in the Canadian pulp stands. The symptoms described by him are very similar to those observed in the study herewith presented, and are attributed to *Stereum sanguinolentum*.

York (5) in a brief report on a newly observed disease of white and red pines in New York State, states that the causal organism is not of the honey mushroom type but produces, however, a root and butt rot of the hosts attacked. The white mottling of the inner bark, resin flow, and sudden death closely resemble the signs observed on the dead white pines examined in Moscow, Idaho.

Lagerberg (2) reports *Stereum sanguinolentum* as a serious wood rotting organism attacking conifers in Sweden. A similar disease was observed by the writer in Alpine firs (*Abies lasiocarpa*) growing in dense stands in mixture with the western white pine and western hemlock of northern Idaho. No sporophores were found on the standing living trees but were collected on the fallen trunks containing the characteristic heartrot.

Symptoms

The external symptoms denoting the presence of the mottled bark disease of conifers caused by *Stereum sanguinolen-*

tum are few and inconspicuous. The presence of the fruiting bodies of this fungus on the living host is rare, and these fruiting structures, small and inconspicuous, are most commonly found on the exposed roots, root crotches, and butt sections of the dead tree. They are, of course, common the full length of the trunk of fallen trees infected with this disease. Resin flow is a common symptom on the lower trunk and the root collar of Douglas fir, the spruces, true firs, and to a lesser extent the white pines. It is most noticeable on the Douglas firs, as whitish streaks on the lower trunk.

That ever-present symptom of most tree diseases, the sudden discoloration of the foliage, appears in late spring or early summer, and is not particularly characteristic of this disease, since this sign may be caused by several other agencies. The needles, with the exception of the spruces, remain on the tree for some time after death. In some cases it has been noted that the discoloration first takes place in the upper crown, and extends downward.

The internal symptoms are more characteristic and constant. The bark on the infected roots, root crown, and lower trunk parts easily from the sapwood, and the inner surface of the bark shows a white mottled appearance (Figure I, A). The white spots vary in shape and size, at times appearing small and lens-shaped but running together to form larger patches and streaks. In older infections the inner bark is almost a mass of whitish discolored tissue and mycelium. Occaionally the white mottled pattern remains on the sapwood surface when the bark is removed (Figure I, B). The lens-shaped areas, when present, remind one of the early developments of a small pocket rot. This is apparently the case here, for in older sections of the trunk of infected larch the sapwood shows characteristic small white to hollow pocket formations. In this connection it is of interest to note that all the wood-rotting species of Stereum produce white pocket rots in the late stages of decay.

The sapwood directly beneath that portion of the bark which shows the white mottlings is always discolored (Figure I, C). The color varies in different wood species, and ranges from light to dark grayish brown. In the later stages of decay the discolored wood becomes softer and spongy, but never takes on the soft, crumbly texture of a brown rot. In the descriptions given by McCallum and by Faull and Mounce (1) the discolored wood is located in the central portion of the heartwood, spreading outward toward the sapwood, either ray-like or uniformly circular in cross-sectional view. In the infected trees studied at Moscow the discolored wood is found near the bark and extends toward the center of the trunk in irregular rays and patches. In some cases the entire cross section is discolored. The Canadian material would indicate a saprophytic fungus entering, as do most heart-rotting organisms, through dead branches and other injuries. A study of the Moscow material points toward a parasitic or near parasitic type of fungus as the causal agency, or at least one which is capable of attacking the living tissues of a weakened or severely injured tree and, after entering the bark, spreading into the sapwood and finally to the heartwood.

The infected trees all showed considerable injuries, such as unhealed pruning cuts, bruising of the lower trunk, and the presence of whorls of small dead branches at the extreme base of the trunk. These small branches were quite frequently buried in the moist duff. Such injuries and dead branches are entrance points for wood destroying fungi, and in dense stands where shade and moisture are plentiful, infection readily takes place.

The Causal Agency

Cultures on malt agar made by using

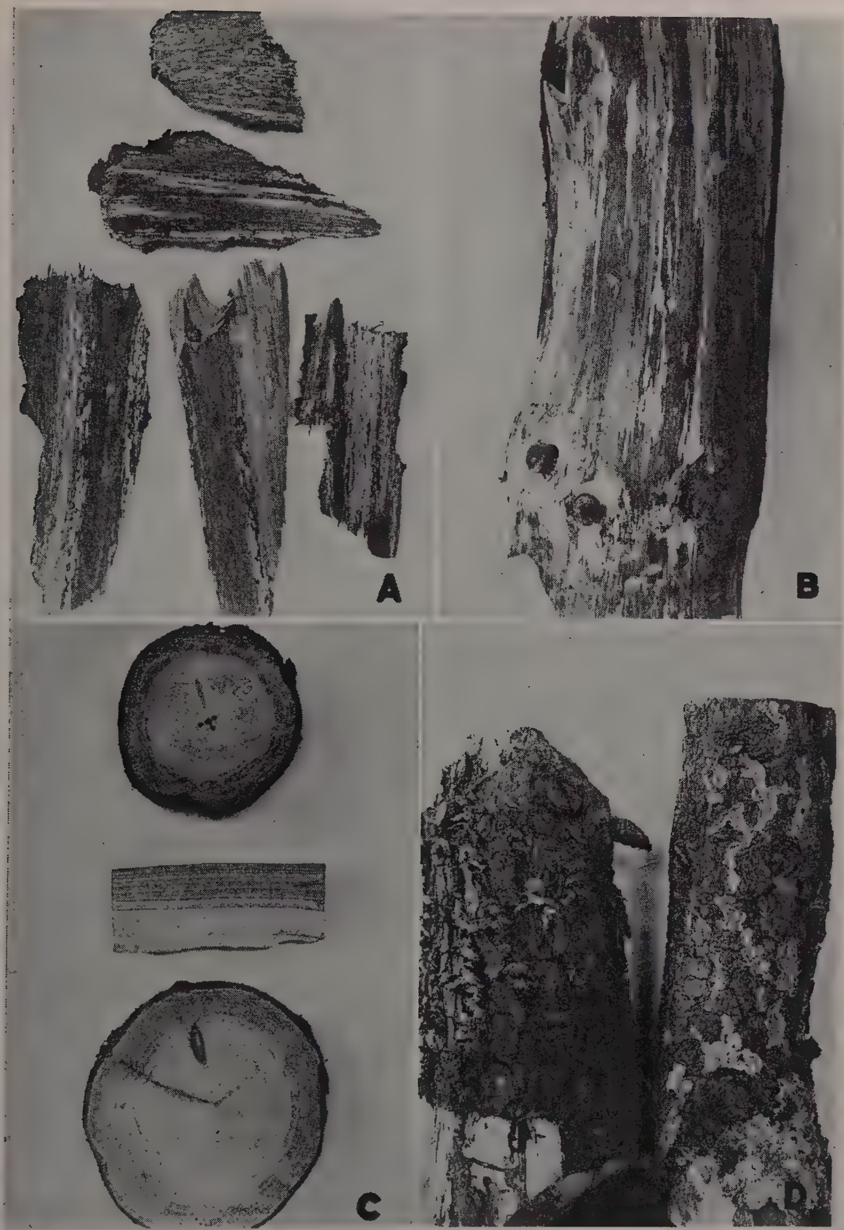

Fig. 1.—A. Showing the white mottling of the inner surface of bark stripped from *Pinus monticola* trees infected with *Stereum sanguinolentum*.

B. The white streaks and mottlings on an infected white pine which appear after the bark is removed. Taken from a dying tree the stump of which later showed several sporophores of *Stereum sanguinolentum*.

C. Sections of young white pines, *Pinus monticola*, showing the brownish discoloration of the sapwood, with the darker and older infection near the bark and the lighter invading border entering the heartwood, caused by *Stereum sanguinolentum*.

D. Sporophores of *Stereum sanguinolentum* appearing on stumps left in the plantation area. The sporophores on the left are of the older reflexed type on *Pinus monticola*, and those on the right are of the younger flat type on *Pseudotsuga taxifolia*.

fragments of the brownish colored infected wood yielded, in the majority of cases, a white, somewhat fluffy mycelial growth which upon aging showed a tendency to form very small hyphal lumps. Later, when sporophores of *Stereum sanguinolentum* were found in great abundance on the exposed roots, root collar, and lower trunk of the stumps remaining in the ground since the previous spring (Figure I, D), cultures were again made, using these fruiting bodies as inoculum. Comparisons were then made between these two series of cultures and stock cultures of the fungus obtained from the Forest Products Laboratory at Madison, Wisconsin. Up to the present time no distinct differences have been noted. The sporophores of this fungus are flat, leathery, and thin, clinging closely to the bark or wood, with the upper portion at times projecting a short distance. The upper surface is grayish in color, hairy, and zonate. The lower, or spore bearing surface, is smooth, conforming to the surface of the host, and of a tan to brownish or purplish black color varying with age. When the fresh under surface is bruised it turns a blood red color.

Damage

In so far as the studies on the mottled bark disease have progressed, the damage produced is sufficient to attempt control measures. A fifty per cent loss within a period of three years in the case of the coast variety of Douglas fir, and relatively smaller losses in the case of the other coniferous species, immediately classes this agency among the destructive timber diseases. The trees die suddenly, and appear to show but few outward symptoms until the year of death, when the crowns turn red suddenly and the peeled bark shows characteristic white mottlings. Preceding these signs a certain amount of resin flow may be observed, but this sign alone would not indicate the presence of any particular disease unless other signs accompanied it.

In 1934 another inspection of the conifer plantations showed little or no increase in damage and a very marked increase in the vigor of the trees, due to improved moisture conditions.

The amount of damage caused by *Stereum sanguinolentum* in the forest has not been determined, and for this reason a study should be made to establish the prevalence of this fungus, the hosts it favors, and the losses suffered through its attacks. Field observations indicate that the organism is common in the forests of Idaho and in the Inland Empire in general. It has been found to produce a serious decay of the heartwood of alpine fir. Most of the collections of the fungus have been taken from fallen trunks, snags, and from stumps, but this in itself is no proof that it does not attack the living tree in the forest, since it does not produce fruiting bodies until after the tree is dead, or, rarely, upon large wounds on living trees.

The causal agency has been recorded as a serious cause of heartrot in the balsam fir forests of eastern Canada, where the pulp timber grows in almost pure stands, and also in Maine.

Stereum sanguinolentum is known as a slash fungus, that is, one which is commonly found attacking the dead and down material in the forest and on logged-off areas. It is the only slash fungus which habitually attacks the living trees in the surrounding stands. Spaulding (4) has noted this fact in his study of slash fungi found on white pine in southern New England.

Control

Because so little is known regarding the details of this disease and its causal agency, control measures based on general principles only could be put into effect upon the areas of planted stock. Cutting and burning the dead diseased

trees and grubbing out the stumps of all such trees and later burning them has been the sole control measure so far attempted. Since wounds at the base of the tree appear to be closely associated with the occurrence of the disease, it is suggested that great care be used in pruning operations to hasten the closing of all wounds, to prevent faulty pruning, and to cover all wounds with a white lead paint or similar protective coating immediately after the cut wood is exposed. Pruning close to the trunk so that no projecting stubs are left, and seeing that the pruned surface is left smooth, sterilized against fungi, and protected from moisture, should prove useful in speeding the development of the callus tissue over such wounds and thus protecting the tree against disease.

It is obvious that the control measures submitted can aid only by reducing the spread of the disease. Trees which were already infected when the control methods were applied can not be aided, but the removal of infected wood and of sporophores can prevent the production of a new supply of infecting spores.

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Forest Management in Canada

UNDER intensive methods of silviculture the forests of France produce, on the average, 44 cubic feet of timber per acre each year; in Germany the average is 50 cubic feet per acre. While such intensive methods are inapplicable in Canada at present, it is estimated by the Forest Service, Department of the Interior, that, if the accessible and productive forest area in Canada were managed so as to produce even ten cubic feet of wood per acre, it would practically replace the present annual depletion through cutting, fire, and disease.

—*Canadian News Bulletin.*

THE RELATION OF JACK RABBITS TO GRAZING IN SOUTHERN ARIZONA

By WALTER P. TAYLOR,[1] CHARLES T. VORHIES,[2]

AND P. B. LISTER[3]

Jack rabbits feed on valuable range vegetation. A preference was found for areas on which livestock grazing had reduced the vegetative stand, provided a moderate forage supply was still available. Similarly, a much greater insect population has been found on overgrazed than on lightly grazed range in Oklahoma. Earlier investigators have traced relationships between vegetative depletion by livestock and a multiplication of grasshoppers and white grubs, and have noted increases of certain small mammals following the disturbance of the native prairies of the Middle West. The results of altered character of plant cover are expressed in terms not only of plant succession but also of animal succession; the associative complex is not merely botanical but is also zoological and therefore inclusively biological; increases of insects and certain vegetation-consuming mammals may be an effect of vegetative depletion rather than primarily a cause, or may be both an effect and in turn a cause; and maintaining in the right balance range use and range vegetation may be a problem into which should be integrated the control of animal life through the kind and amount of vegetation. For foresters, already accustomed to think of the forest as a biological complex comprising the animal as well as the plant life of the area, new vistas are brought into view by this highly suggestive paper relating to the range.

UNDER original conditions, jack rabbits, rodents, prong-horned antelope, and other game species were in fluctuating equilibrium with the range forage, which they were powerless to injure seriously. With the introduction of livestock, however, the situation was profoundly altered. The large grazing wild mammals were to a great extent eliminated, and their places taken by a weight of livestock in many cases out of all proportion to the carrying capacity of the range. In many instances the climax grasses were eliminated, and annual grasses, herbs, and weeds of various kinds and qualities appeared. In some areas jack rabbits and certain rodents also appeared in large numbers. What more natural than to blame the rabbits and rodents for the observed range depletion, or a considerable part thereof?

For it is well known that jack rabbits, for example, under present conditions, do feed extensively on valuable range vegetation. Vorhies and Taylor (6) bring out such facts as the following: That only 15 antelope jack rabbits would be required to eat as much valuable range forage as one sheep, or 74 as much as a cow; that 30 Arizona jack rabbits would eat as much as one sheep, and 148 as much as one cow (p. 516); that rodents and rabbits, mainly jack rabbits, consumed 28.7 per cent of the total vegetation on clipped sample plots, on the Santa Rita Experimental Range, or 38.8 per cent of the valuable forage grass (pp. 518-519); that grass made up 45 per cent of the food of the antelope jack rabbit and 24.1 per cent of that of the Arizona jack rabbit as determined by stomach analyses (pp. 524-525). But the acknowledged forage consumption by jack rabbits under existing range conditions is not the whole story.

For many years the writers have observed that jack rabbits quite generally occur more abundantly in open areas than in heavily grassed tracts. This appears to be true wherever the animals

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wander. In the Middle West, for example, as pointed out in conversation by President H. L. Kent, one hunts jack rabbits in open pastures rather than on well-grassed prairie lands.

It occurred to the writers that close study by means of the pellet count (4, p. 531) of jack rabbit occurrence on some of the fenced sample plots and pastures maintained by the U. S. Forest Service on the Santa Rita Experimental Range[4] might afford significant data.

Perhaps brief reference should be made to the pellet count. Jack rabbits regularly defecate as they feed, or very soon afterwards. Thus there is a significant relation between numbers of pellets and the abundance of jack rabbits grazing on a given area. Though the pellet count gives no information on absolute numbers, it is a reliable method of determining relative abundance. A wire hoop enclosing approximately 1 square foot is placed on the ground, and the number of pellets within the hoop counted and recorded. Then the observer walks 50 feet, and again places the hoop and makes a count. This procedure is continued until 30 counts or more are made for each area or plot sampled.

The first area to be given attention was Box Station, a series of stock exclosures set up by the Forest Service in 1922 to show what happens to the forage grasses of the upper mesa type under different conditions of deferred grazing, as follows:

1. In plot A, grasses were exposed to grazing during the growing season (July, August, and September), but closed to cattle grazing on October 1 and during the remainder of the year.[5]

2. In plot B, grasses were protected year-long for the grazing years 1930-31, 1931-32, and 1932-33. Between July 1, 1922, and June 30, 1930, plot B was protected July 1 to September 30, grazed October 1 to January 31, and protected the rest of the grazing year (to June 30).

3. In plot D, outside the fences, grasses were exposed to year-long grazing.

Thus plot A was grazed in the growing season and was characterized by a relatively small volume of grasses (see Figure 1); plot B was for all practical purposes under total protection and showed a relatively large volume of grasses, while plot D, outside the fences, was doubtless grazed pretty continuously and showed

TABLE 1

RELATIVE IMPORTANCE OF GRAZING USE OF RANGE GRASSES, BOX STATION, SANTA RITA EXPERIMENTAL RANGE, ARIZONA, JUNE 30, 1933

Kind of grass	Plot A		Plot B		Plot D	
	Per cent of total stand	Per cent of proper utilization	Per cent of total stand	Per cent of proper utilization	Per cent of total stand	Per cent of proper utilization
Bouteloua rothrockii	81	70	70	20	87	105
B. filiformis	4	85	6	20	2	105
B. chondrosioides	1	90	0	0	Trace	105
B. eriopoda	10	90	11	20	6	110
Valota saccharoides	3	100	10	20	2	110
Heteropogon contortus	1	65	2	15	Trace	95
Aristida spp.	Trace	95	1	20	Trace	100
All grasses	100	70.45[1]	100	21.96[1]	100	104.48[1]

[1]Computed on the basis of per cent of stand (weighted) for each individual grass.

[4]A field station of the Southwestern Forest and Range Exp. Sta., U. S. Forest Service.

[5]In the summer of 1932 (July, August, September) plot A was grazed conservatively (but 15 per cent) due to a temporary water shortag e in this part of the pasture.

the least grass volume of any of the areas.

It should next be pointed out that some of the grasses in these plots responded quite differently to different degrees of grazing pressure, both in percentage of total stand and percentage of proper utilization. Table 1 shows the condition existing on June 30, 1933, the close of the grazing year.

It will be observed that Rothrock grama (*Bouteloua rothrockii*), a short-lived perennial, was most abundant in plot D, outside the fences, where it was most closely grazed. It was next most abundant in plot A, which was grazed in the growing season, and least abundant in plot B, which had been for some time under total protection, and where the grass was least utilized. Similar nearby plots, protected from grazing for 17 years, indicated that if plot B had been fully protected from grazing for the entire 11 years (from 1922 to 1933) instead of 3 years, the observed relationship would have been even more striking.

The other perennial grasses, including all those listed in the table, showed a contrary relationship. They were most abundant in plot B, under total protection, next most abundant in plot A, grazed in the growing season, and least numerous outside the fences in plot D, while the percentage of their utilization was least in B, next in A, and most in D.

In spite of the fact that there was no barrier about any of the plots that would prevent grazing by jack rabbits, it was soon apparent that these animals were not giving equal attention to the three plots.

Plot A was grazed by cattle through the growing season (July, August, September, 1932). In this period the cattle had utilized the grasses about 15 per cent only. Examination on June 30, 1933 (after protection from cattle all winter), however, showed 70 per cent utilization, the difference of 55 per cent being undoubtedly due to jack rabbits,[6] rodents, and windfall. On the other hand, the grasses in plot B, which were not grazed at all by cattle, showed only about 22 per cent utilization (obviously by jack rabbits, rodents, and windfall) throughout the entire year (July 1, 1932, to June 30, 1933). The cattle-grazed plot had been a good deal more heavily grazed by jack rabbits and rodents than the protected plot.

To test this quantitatively we resorted to the pellet count previously mentioned, the results being given in Table 2.

It will be noted that jack rabbits as indicated by the pellet counts were more than three times as numerous in plot A (grazed in the growing season) as in plot B (protected). On the outside area (D) jack rabbit grazing was not so heavy as in plot A, possibly because of a lesser amount of attractive and succulent vegetation. But in spite of the closely cropped condition of the vegetation on the outside, jack rabbit pressure was nearly twice as

[6]It will be noted that but 15 per cent of the *current* use in this area (plot A) is attributable to cattle, but this figure by itself is misleading. The summer grazing use of plot A from 1922 to June 30, 1933, has resulted in a loss in density of the perennial grasses (black grama, three-awn, etc.) with an increase in density of Rothrock grama (*Bouteloua rothrockii*). The composition of the vegetation during the summer of 1932 was the accumulated result of grazing over a period of years. In contrast, plot B has benefitted by the accumulated result of protection during the main growing season since 1922. This protection has shown a relative increase in density of the perennial grasses (good forage) with a corresponding decrease in Rothrock grama.

It would not be expected that one season of conservative grazing when plot A was utilized only 15 per cent would show up the advantages of conservative grazing, for as explained, the area had been subjected to heavy grazing pressure over the previous 10 years. The point to be emphasized is the much heavier use by jack rabbits of the relatively heavily grazed plot A as compared with the lighter use by jack rabbits of the protected plot B.

heavy there as on the well-grassed plot under total protection.

It seemed significant that the jack rabbits chose to graze the finer stemmed, short-lived annuals and perennials on plot A in preference to the perennial grasses of plot B, though the latter were present in far greater volume and were equally accessible, being "protected" by a barbed-wire stock fence only.

These observations and pellet counts at Box Station led to studies in a number of other locations on the Range, some of the results of which are given in Table 3.

In every instance examined jack rabbits were more abundant and jack rabbit pressure heavier on the grazed plots than on ajoining protected plots, although the animals had equal access to both. It will be noted that the pellets were 1.7 to 4.3 times as numerous in the grazed as in the protected plots.

On November 16, 1933, the occurrence of jack rabbits was further checked in two large pastures. Pasture 9, in the foothill type, is lightly grazed, the grasses (*Valota saccharata, Bouteloua filiformis, B. curtipendula, B. hirsuta, Andropogon* sp., and *Aristida* sp.) well-developed. In an adjoining pasture (pasture 7), the grasses were grazed off short. The pastures were apparently identical in slopes, exposure, soil, altitude, and all factors other than grazing. Pellet counts made in these adjoining pastures showed respectively 17 jack rabbit pellets on 30 square feet counted over a 1,500-foot route in the heavily-grazed area (pasture 1), and but four jack rabbit pellets on 30 square feet counted similarly in the lightly grazed, thickly grassed area (pasture 9). According to the pellet counts, then, jack rabbits were four times as numerous in the heavily grazed pasture as in the lightly grazed one.

As the observer made these counts, he noted that almost a cloud of grasshoppers flew up as he crossed the heavily-grazed field (pasture 1), while but an occasional hopper appeared in the thick grass (pasture 9). The grasshoppers were not given quantitative attention as the weather shortly became colder and grasshoppers everywhere decreased markedly in numbers. Further reference will be made to the grasshopper situation a little later.

We have frequently observed that where cattle stand or graze in the shade of a large mesquite tree, the grass is closely cropped over a space of several square rods and that on these grazed areas jack rabbit pellets are a good deal more numerous than on the surrounding more grassy areas.

There seems to be no question that jack rabbits prefer grazed areas as compared with areas under total protection, or areas lightly grazed. How can we account for this partiality? Perhaps the jack rabbits do not like the course, dry grass of the less grazed tracts. They do seem to be partial to open weedy tracts rather than climax grass areas. We have an impression that the animals like certain annual weeds much better than they do the grasses, a point which has been suggested by Cooperrider also. Visibility is doubtless an important factor in jack rabbit occurrence in more open areas. Apparent-

TABLE 2

RABBIT PELLET COUNTS, BOX STATION, SANTA RITA EXPERIMENTAL RANGE, ARIZONA, 1934

	Cottontail pellets				Jack rabbit pellets			
	On 30 sq. ft.		Per sq. ft.		On 30 sq. ft.		Per sq. ft.	
Plot	July 28	Oct. 31	July 28	Oct. 31	July 28	Oct. 31	July 28	Oct. 31
A	277	173	9.2	5.7	31	44	1.0	1.0
B	85	55	2.8	1.8	170	150	5.6	5.0
D	146	139	4.8	4.6	36	71	1.2	2.3

ly a jack rabbit feels safest where it can see or hear an enemy approaching. Whatever the explanation, the greater frequency of jack rabbits on grazed land as compared with more grassy areas is unmistakable.

It should be pointed out that while jack rabbits, according to these observations, increase with grazing, this increase is only up to a certain point. When overgrazing goes so far that there is but little valuable forage left, then jack rabbits are reduced. They apparently reach their maximum of numbers on grazed areas where a moderate amount of forage still is available. Thus, at the Box Station plot jack rabbits were more abundant in plot A, where available succulent vegetation was doubtless more abundant, than outside the fence (plot D) where the vegetation was shorter. Where grazing goes too far, rabbits will be less abundant for the very obvious reason there is less for them to eat.

But note that the grasses in plot B were saved from any great amount of jack rabbit work by virtue of their own luxuriance and thickness; while the grasses in plot A, which were grazed by livestock during their growing season, were subjected to the heaviest jack rabbit pressure of all.

The work here reported seems significant in view of results secured by some other investigators. Thus Weese, on the basis of studies of insects on the Wichita National Forest and Game Preserve, has found a marked difference in the occurrence of insects as between a conservatively grazed and an over-grazed pasture. He has kindly sent us his unpublished notes as follows:

"Over a period of about a month (June 6 to July 3, 1928), quantitative collections of insects were made by sweeping with an insect net in the 'Buffalo Pasture' in the Wichita National Forest and Game Preserve, Okla., and in an overgrazed area about one hundred meters distant. The area within the pasture was characterized by a good stand of prairie grasses, with *Andropogon scoparius* as the most conspicuous dominant. As the pasture of approximately 9,000 acres was

TABLE 3

RABBIT PELLET COUNTS, SANTA RITA EXPERIMENTAL RANGE, ARIZONA[1]

Location and character of areas	Jack rabbit pellets Number on 30 sq. ft.	Jack rabbit pellets Number per sq. ft.	Cottontail pellets Number on 30 sq. ft.	Cottontail pellets Number per sq. ft.	Date of count 1934
Forest Station; Foothill type:					
Grazed by cattle	92	3.06	33	1.10	March 16
Not grazed by cattle	24	.80	71	2.36	March 16
Eriopoda Station; Mesa type:					
Grazed by cattle	90	3.00	63	2.10	March 16
Not grazed by cattle	52	1.73	120	4.00	March 16
Road Station; Mesa type:					
Grazed by cattle	30	1.00	147	4.90	March 22
Not grazed by cattle	7	.23	200	6.66	March 22
Southwest Station:[2]					
Grazed by cattle	40	1.33	75	2.50	March 22
Not grazed by cattle	18	.60	130	4.33	March 22
All plots,[3] *including Box Station:*[4]					
Grazed by cattle	537	2.98	475	2.63	
Not grazed by cattle	241	1.33	842	4.67	

[1]In some of the smaller plots the interval between the plot counts of pellets was reduced from 50 ft. to 10 ft. Care was taken to see that the counts were representative of general conditions in each plot considered.

[2]On line between mesa and semi-desert types.

[3]180 counts altogether, made at different times; see above, and also Table 2.

[4]See Table 2.

grazed by about 200 bison, it was not subjected to undue grazing pressure. The station outside the fence was at that time and had been for several years heavily overgrazed by cattle. *Andropogon scoparius* was practically absent, and there was an excessive growth of forbs with a great many Compositae. The following tables give comparative data as to the insects and spiders collected in the two areas."

On the basis of observations of this type Weese announced that insects could be excluded with a barbed wire fence. That is, holding stock pressure to a moderate or low point permitted the growth of a type of vegetation on which the number of certain kinds of insects was very much lower than in overgrazed pastures nearby.

The principle of excluding range pests such as insects by simply fencing out cattle is not new. Treherne and Buckell (5) have traced the connection between range depletion and outbreaks of noxious grasshoppers in British Columbia. A number of species of these pests find the bare, open overgrazed areas well suited to oviposition, and consequently to reproduction. As a result, grasshoppers have increased in numbers as the original tall grass cover has been removed, and have at times attained plague status. These investigators conclude (p. 7):

"It is not necessary, however, to rely on hearsay to realize that where the numbers of stock to the area available for ranging is in judicious proportion or where rotations of grazing grounds are practiced, grasshoppers do not, or even cannot, permanently injure the range grasses." (p. 10): ". . . The stock themselves are primarily responsible for the disappearance of the range grasses. Drought and the influence of grasshoppers are secondary factors." (p. 11): "It is now known that the most injurious species are those that prefer an open, bare, parched, low-grassed range condition." (p. 35): ". . . the control of grasshoppers on the range mainly rests on the question of the re-establishment of the range grasses." "The species that occur on a depleted range are the most likely to prove injurious, hence, measures taken to improve the range also lessen the danger of an outbreak. Judicious management of cattle within selected grazing limits is the keynote of success in grasshopper control on the range."

These results of Treherne and Buckell suggest the desirability of quantitative checks on insects on the Santa Rita under different conditions of vegetation and stock-grazing pressure.

Fluke, Graber, and Koch (1, p. 50) found that permanent blue grass pastures (in southern Wisconsin) with thick or very dense sods resulting from judicious grazing, ample fertility, and favorable moisture conditions are relatively free from infestations of white grubs. Where the turf was thin grubs were much more numerous. Weaver and Flory (7, p. 345) mention increase in the striped ground squirrel, ants, and pocket gophers in the native prairie of the Middle West as a result of disturbance such as overgrazing, surface erosion, or cropping.

Fig. 1.—Box Canyon Station, Santa Rita Experimental Range, Ariz. Looking north along division fence between plot A (cattle-grazed last summer) and plot B (open to rabbits and rodents but not to cattle). Jack rabbits are nearly three times as abundant in the tract on the left as in the well-grassed plot on the right.

But let us advert again to the jack rabbits, in the light of the observations here reported and the results of these other investigations.

It is obvious that jack rabbits have not prevented the growth of a considerable volume of grass where areas have been given protection from livestock. The condition in plot B at Box Station (Figure 1) is fairly typical of this, and pasture 9 appears to be another example on a much larger scale.

The behavior of jack rabbits (and probably of certain other rodents) puts one in mind of Sampson's findings (2) on plant succession and range management. Sampson found that where unfavorable conditions killed out the subclimax wheatgrass cover in the Wasatch Mountains, Utah, a secondary cover, made up of porcupine grass and yellow brush, came in. The secondary stage was the result of such unfavorable conditions as too early grazing, overstocking, etc. It appears that grazing may also increase the number of insects, jack rabbits, and certain other rodents. Some of the animals behave successionally like the plants. Results of grazing are expressed not only in terms of weeds and annual grasses, but of animal "weeds" also. Both animals and plants are likely to be different on a grazed area from what they are on an ungrazed or lightly grazed area. The problem of the secondary stage that replaces the climax or subclimax stage under unfavorable conditions can be more accurately described as a biological problem than a botanical or a zoological problem alone.

Thus jack rabbits and doubtless certain rodents and insects may at times be results of grazing as well as being causes thereof. It seems quite clear that up to a certain point jack rabbits and rodents will increase as grazing pressure by livestock increases.

As in the case of Weese's insects, if one could hold stock pressure to a point where a sufficient volume of grass is maintained, jack rabbits will be less numerous. To a certain extent one can keep out jack rabbits with a barbed wire stock fence.

In his observations on the grasslands of the central United States, Schaffner (3, p. 14) says the prairie dog has migrated eastward since the advent of civilization in Kansas because of the eastward development of buffalo-grass through pasturing. But in the same paper he asserts (pp. 45-46) that the prairie dog is favorable to the extension and perpetuation of *Bulbilis* and *Bouteloua* because of its close crop-

TABLE 4

TOTAL INSECTS PER COLLECTION OVER A PERIOD OF APPROXIMATELY ONE MONTH[1]

Date	Overgrazed area	Normal area	Date	Overgrazed area	Normal area
June 6	60	65	June 20	141	24
7	56	33	21	123	28
8	149	----	22	----	66
9	182	34	23	106	39
10	177	105	24	106	58
11	199	44	25	227	32
12	90	73	26	22	117
13	95	65	27	141	30
14	95	51	28	104	29
15	----	----	29	207	44
16	262	21	30	124	20
17	256	30	July 1	248	33
18	119	13	2	199	32
19	126	26	3	446	30

[1]Data on overgrazed area based on single collections, data on normal area based on averages of two or three collections each day.

ping of vegetation. This seeming inconsistency is not necessarily an inconsistency at all, for the prairie dog, like certain other rodents, may well be, under different conditions, both an effect and a cause.

The status of jack rabbits on the range, like that of the prairie dogs referred to by Schaffner, varies, doubtless at times being a cause, at others an effect, and at still others perhaps being neither.

The present writers have been unable to obtain any evidence of the elimination of the grass climax or subclimax by jack rabbits or rodents independent of livestock.

It should perhaps be noted that thick grass, as in plot B at Box Station, favors the increase of cottontail rabbits, and doubtless also of cottonrats. As our tables (2 and 3) show, the numbers of cottontails are always greater where the cover is best, just the reverse of the case with jack rabbits. Neither cottontails nor cottonrats are known to be seriously detrimental to range forage, although both will bear investigation. The cottonrat has a bad reputation for eating the eggs of quail and other ground-nesting birds, as well as foodstuffs of man in cultivated areas.

At this point some very practical questions arise:

Can the range be rehabilitated if jack rabbits are present?

No one answer is possible, since local conditions must govern. Where livestock pressure is moderate, and the vegetation close to a balance between improvement and deterioration, jack rabbits might tip the scale downward. Where livestock pressure is heavy, its effects will be preponderant and jack rabbit effects may be serious also. In any case, jack rabbit control will be most effective where livestock grazing is adjusted so that the range will have a chance.

Would it be economically practicable to maintain a climax or subclimax grass cover of sufficiently luxuriant character to have any effect in holding down the numbers of jack rabbits, certain other rodents, and insects?

No one answer is possible to this question either, since local conditions must govern, and more information is needed on every point.

It is felt that such information as we have about jack rabbits and certain rodents, as related to range conditions, while perhaps not conclusive, fits in to the following:

(1) Under original natural conditions vegetation and animal life were in fluctuating balance.

(2) Under disturbance through grazing by livestock, problems are certain to arise. These include not only problems of less valuable plants (Sampson, 1919) but also animals (Treherne and Bucknell, 1924; Weese; the present paper, etc.).

(3) The stock is primarily responsible for the disappearance of the range grasses. The influence of rabbits and rodents is a secondary factor.

(4) The exact degree to which the increase of undesirable plants and animals can be controlled by careful regulation of livestock pressure remains to be determined. The reader can form his own conclusions regarding the significance of the facts as stated. It seems to the writers that careful and conservative range management will tend to obviate difficulties with jack rabbits and certain rodents as

TABLE 5

POPULATION PER ACRE (IN THOUSANDS)

	Coleoptera	Diptera	Hemiptera	Homoptera	Hymenoptera	Orthoptera	Total
Overgrazed	118	30	100	214	140	180	782
Normal	50	28	8	52	28	20	186

well as with some of the undesirable weeds.

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Table 6

COMPARATIVE NUMBERS OF REPRESENTATIVE SPECIES

Species	Average number per collection (50 sweeps of insect net)	
	Overgrazed	Normal
Scolops spurcus	12.0	0.9
Campylenchia latipes	14.5	0.05
Leptysma mexicana	13.0	1.7
Melanoplus sps.	18.0	1.2
Lygus pratensis	2.0	0.0
Corimelæna pulicaria	1.0	0.01
Harmostes reflexulus	2.0	0.05
Thomisidæ	1.6	0.7
Tibellus duttoni	0.2	0.8
Oxyopes salticus	0.5	1.2
Melanotus communis	0.04	1.5
Tanymecus lacæna	1.0	2.0
Anomala innuba	0.1	0.5
Colaspis favosa	0.0	0.2

THE GROWTH OF SPRUCE AND FIR ON THE WHITNEY PARK IN THE ADIRONDACKS

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Unique was the opportunity to study the results of one of the earliest examples of practical forestry in the Adirondacks. The Whitney Park is being logged a second time. The predicted cutting cycle of 36 years has been exactly fulfilled. The growth of softwoods has been extraordinary, and proves the value of forest management.

THE Whitney Park was chosen in 1898 by the United States Division of Forestry, as one of several tracts on which government agents planned to illustrate the feasibility of forest management on private timberlands, through cooperation with the owners. Dean H. S. Graves, then with the Division of Forestry, directed the work on the Whitney tract and described the project in a government bulletin.[1] The Park, originally comprising 68,000 acres, was acquired by the late W. C. Whitney in 1897. It is located in the town of Long Lake, Hamilton County, New York. The original stand of timber was typical of the virgin Adirondack forests, and Graves estimated the distribution of the four commonly recognized Adirondack forest types as follows:

Swamp	20 per cent
Spruce Flat	30 per cent
Hardwood	40 per cent
Spruce Slope	10 per cent

Guided by Dean Graves' recommendations, the entire tract was logged by a selection method during the period 1898 to 1909. Only the spruce and pine were cut, leaving the fir, the hemlock, the hardwoods, and the spruce 9 inches and below in d.b.h. By use of this 10-inch minimum diameter limit, a similar cut of spruce was predicted in 36 years. The marking rules adopted for the Park required that all trees to be cut should be marked in advance of logging. In addition, sufficient spruce seed trees over 9 inches d.b.h. were left to provide ample spruce reproduction.

Efforts were made in the logging to protect the advance reproduction, and to reduce the waste in logging by cutting low stumps and through close utilization of the trees felled. The logging method consisted of horse skidding, followed by sled haul in winter. The pulpwood was hauled to the numerous waterways of the Park, and subsequently driven to Big Tupper Lake.

During the ensuing period from 1909 to 1934, no further cutting has taken place on the Whitney Tract. Ample fire protection has been provided, however, and most of the area has remained in a state of naturally high productivity.

The Second Cut

The second cut was initiated in the summer of 1934, on part of the area logged in 1898, 36 years having elapsed between the two cuts. At present, the fir is being cut for pulpwood in addition to the spruce, and the hardwoods and the hemlock are being logged following the pulpwood operation.

An approximate breast-high diameter limit of 8 inches was chosen for the spruce and 7 inches for the fir, 10 inches for the hemlock, and 12 inches for the hardwoods. No marking was done on the 1934 operation, but it is planned to

[1] U. S. D. A. Div. of For. Bull. No. 26, Practical Forestry in the Adirondacks, 1899.

have a trained marking crew mark all the trees in advance of logging for the 1935 and following cuts.

The pulpwood is being logged by the same method as for the first cut. The hardwood and hemlock logs, however, are horse skidded to landings, and then hauled directly to their destinations at Tupper Lake.

Through the orderly sequence of cutting, it is planned to spread the present cut over a period of approximately ten years, thus extending the plan for a periodic sustained yield another 36 years into the future.

The Growth Study

A growth study of the spruce and fir was made on a representative portion of the Park during the last week of August, 1934, by the senior class of the Department of Forestry, Cornell University. The area chosen lies on either side of the old tote road running from the Tupper Lake-Long Lake state highway to LaPorte's logging camp. This area of 667 acres comprises three of the major Adirondack forest types, namely: (1) Swamp, (2) Softwood Flat, and (3) Hardwood. The fourth type, Softwood Slope, was found on the south side of Buck Mountain, which is a nearby peak rising to a height of approximately 2,500 feet.

The area along the tote road was last logged in 1898, and the Buck Mountain slope in 1899. Fires have not occurred, nor any serious insect or fungus depredations, so that the area is representative of the normal growth.

The method of studying the growth was by means of quarter-acre plots spaced five chains apart on parallel strips ten chains apart. On the quarter-acre plots, the softwoods were calipered down to five inches, inclusive, and the hardwoods (also the pine and hemlock) down to 11 inches d.b.h. inclusive. Next, on these quarter-acre plots all the living spruce and fir were bored at breast height with an increment borer, and the radial growth by decades measured. Where possible to do so, these measurements were extended beyond the fourth decade, but emphasis was laid on getting four decades in order to cover the growth since the last cutting. In taking the growth measurements, the crowns of the trees were classified according to dominant, intermediate, and suppressed. Altogether 124 plots, or 31 acres, were measured. No plots were laid off in the black spruce bogs.

The radial growth figures were then computed for each diameter and crown class, by types. Next, these averages were plotted on cross section paper,

Table 1

PROGRESS OF DIAMETER GROWTH OF DOMINANT SPRUCE AND FIR ON WHITNEY PARK IN THE ADIRONDACKS—FLAT TYPE

Year	Diameter breast high, inches								
	Spruce								
1898	3.0	3.3	4.6	4.9	6.0	7.1	7.7	8.1	9.1
1934	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1970[1]	9.0	10.7	11.4	13.1	14.0	14.9	16.3	17.9	18.9
	Fir								
1898	2.6	2.5	3.4	3.7	4.3	5.3	5.8	7.0	8.0
1934	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
1970[1]	9.4	11.5	12.6	14.3	15.7	16.7	18.2	19.0	20.0

[1] The diameters indicated for 1970 are "stepped up" on basis of growth from 1898 to 1934 of the same trees; in the corresponding diameter class, the growth is considerably greater—e.g., present 6" spruce will be 10", 7" will be 11", etc. These results should be achieved under present growth conditions. The lower diameters are however a safer basis, considering probable loss through mortality.

which enabled the drawing of a vertical line at the exact year of the cutting and the reading of the radial growth since that year to the present. For example: When the data for the dominant ten-inch d.b.h. spruce on the Flat Type were thus plotted, it showed that the average tree, now ten inches d.b.h., had, since 1898 (the year of the last cut), grown two inches in radius at breast height, or four inches in d.b.h. Consequently, in 1898 this tree was 6.0 inches d.b.h. If its growth were to continue unabated for the ensuing 36 years, or until 1970, it would then be 14.0 inches in d.b.h. This method also enables the determination of the number of years elapsed since the tree was an inch smaller in d.b.h., which in turn makes it possible to compute the current annual increment (c.a.i.). This process of curving the data was carried through all the diameters and types, separately for the three crown classes so far as data permitted, and from it resulted tables like Table 1.

Results of the Growth Study

There is no available record of the stand in 1898, either before or after cutting. In Bulletin 26, the statement is made that on an average, 14.6 standards of spruce were cut per acre at that time. This is roughly equivalent to 5.84 cords per acre, based on log scale. Including all trees 5 inches d.b.h. and up, the plots in the Flat Type taken in 1934 averaged 8.63 cords per acre of spruce, based on pulpwood volume tables. The trees 10 inches d.b.h. and up (the diameter limit of 1898), averaged 5.20 cords of spruce per acre, which is practically an "equal second cut."

The average stand of softwoods 5 inches d.b.h. and up, per acre of the Flat Type measured in 1934, is shown below:

79 spruces, total volume	8.63 cords
56 firs	6.16 cords
135 softwoods	14.79 cords

Cutting this average acre of Flat Type to 8 inches d.b.h. for spruce and 7 inches d.b.h. for fir (the recommended diameter limits) will remove 11.13 cords, composed of 6.16 cords of spruce and 4.97 cords of fir. The increment, as indicated below, will be sufficient to replace the amount removed in about 23 years. Thus periodic sustained yield is assured, but should be checked for inevitable losses through mortality following logging by means of accurately remeasured sample plots in the cutting area.

The current annual increment per acre of spruce and fir on the Flat Type is as follows:

	Cords	Per cent of present volume
Spruce	.2213	2.6
Fir	.2527	4.0
Total	.4740	3.2

Long time observations by Finch, Pruyn & Co. have shown that the optimum diameters of spruce and fir for pulpwood are 9, 10, and 11 inches d.b.h. Table 3 shows, for each forest type, that by cutting spruce to (not including) 8 inches d.b.h. and fir to (not including) 7 inches d.b.h., the residual trees will not exceed an average of 11 inches d.b.h. at the end of the next 36-year cutting cycle, or in 1970.

Table 2

CURRENT ANNUAL INCREMENT PER CENTS (PRESSLER) OF DOMINANT SPRUCE AND FIR ON WHITNEY PARK IN THE ADIRONDACKS FLAT TYPE

D.b.h.—inches. 1934	6	7	8	9	10	11	12	13	14
C.a.i.—per cent. Spruce	3.6	2.9	2.5	2.5	2.7	2.9	3.0	2.9	2.6
C.a.i.—per cent. Fir	4.9	5.5	5.7	5.5	4.9	4.1	3.4	2.9	2.4

Conclusion

The results of this second cut under regulated management will be watched with great interest by foresters and timberland owners alike. The conservative cut of 1898-1909 has enabled the present profitable operation, and if similar care is exercised in the second cut, continuous operations on the basis of periodic sustained yield are assured.

Table 3

BREAST HIGH DIAMETER OF SPRUCE AND FIR, 1934 AND 1970. FOR ALL TYPES, WHITNEY PARK, ADIRONDACKS, AND 1970 DIAMETERS OF 1934 RESIDUAL STAND[1] AFTER REMOVAL OF ALL SPRUCE ABOVE 8 INCHES AND ALL FIR ABOVE 7 INCHES

Diameters 1934	Inches 5	Inches 6	Inches 7	Inches 8	Inches 9	Inches 10
Diameters, 1970:						
Flat Type—Spruce	8	8	10	11	*12*	*13*
Flat Type—Fir	8	9	11	*12*	*14*	*15*
Swamp Type—Spruce	7	8	9	11	*12*	*12*
Swamp Type—Fir	7	8	9	*11*	*12*	*14*
Hardwood Type—Spruce	7	8	9	11	*12*	*14*
Hardwood Type—Fir	8	9	11	*13*	*14*	*14*
Slope Type—Spruce	7	8	10	10	*12*	*13*

[1]Figures not in italics.

The Central Forestry Society of Belgium is organizing an International Congress of Silviculture and Fuel Carbons to be held at Brussels, Belgium, July 26 and 27, 1935. The Congress will be divided into four sections: (1) silviculture and forest management; (2) dendrology, genetics and protection; (3) economics of wood; (4) use of charcoal.

The papers to be presented at the Congress should be sent to the Organization Committee of the Society by June 10, 1935.

THE SIGNIFICANCE OF SOIL TEXTURE IN FORESTRY, AND ITS DETERMINATION BY A RAPID FIELD METHOD

By S. A. WILDE

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SOIL material may be divided into two fractions: coarse material, which includes particles larger than 0.05 mm. in diameter, viz. stones, gravel, and sand, and fine soil material, which includes particles smaller than 0.05 mm. in diameter, viz. silt, clay, and colloids. The separation of these two fractions is made by shaking soil with water and allowing the suspension to settle. After one minute, the coarse soil material has settled, whereas the fine soil material stays in suspension. The relative amounts of the coarse and fine soil materials determine soil texture, which is closely related to the distribution and rate of growth of the forest vegetation (3).

The coarse soil material represents the "skeleton" of the soil; its function is largely limited to the physical support of plants, and it is practically inactive in plant nutrition. On the other hand, the fine soil material is the active portion of the soil, which through its absorptive and nutritive properties fulfills manifold ecological functions. It is the carrier of life in the soil, or as Stebutt (5) says, it is the "soil protoplasm."[1]

The Influence of Soil Texture Upon the Natural Forest Growth

The ability of soil to retain water depends upon the amount of the fine soil material present. The higher the amount, the greater is the soil moisture content, other conditions being the same. Since the soil pores are filled with either water or air, an increase in the fine soil material, and consequently in soil moisture, leads to a decrease in soil aeration. Finally, the fine particles are the chief source of easily soluble substances, which serve the trees as nutrients.

Thus, soil texture materially influences the three basic factors in forest growth: soil moisture, soil aeration, and soil nutrients. Because various tree species have different requirements for these three factors, their distribution and rate of growth are often closely correlated with the soil texture. In general, soils with a low content of the fine soil material, i.e. sandy soils, support only trees which have low requirements for moisture and nutrients, viz. pines, scrub oaks, white birch, aspen, etc. On the contrary, soils with a high content of the fine particles, i.e. loamy soils, support trees which have high requirements for moisture and nutrients, viz. species of spruce and fir, hard maple, basswood, elm, white ash, etc.

In some cases the distribution of forest trees shows such a remarkable correlation with the soil texture that it has been noticed even by non-technical people. For instance, the settlers in the Lake states region of America, in the early days of colonization, classified the textural features of agricultural soils according to the following scale: "hardwood soils," "white pine soils," "red

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[1]Perhaps the colloidal fraction (particles less than 0.0001 mm. in diameter) is alone responsible for the activity of the fine soil material, since the absorptive ability of colloidal particles is incomparably greater than that of the silt and coarser clay. However, the colloids tend to adhere to the silt and clay particles, and cannot be completely separated in the ordinary analyses of soil. This is probably the reason why the forest growth has been found to be correlated with the amount of the total fine soil material, and not with the amount of soil colloids alone.

pine soils," and "jack pine soils" (4).

On the other hand, there may be found in the virgin forest many instances where the correlation of soil texture and forest growth is masked by the influence of other factors, especially by the ability of forest stands to modify the environment. Through a succession of pioneer and basic species, the forest stands adjust the soil to the requirements of the tree species which compose them. For example, the cut-over sandy soils of Wisconsin are suitable only for jack pine, or at best, for red pine. However, as soon as these pioneer species become established, they moderate the extremes of climate, particularly high temperature, with the canopy of their crowns, and accumulate mulch and humus which increase the water holding capacity and supply of plant nutrients of the soil. Thus they create conditions suitable for the establishment of white pine, which may gradually replace the pioneer species. Similarly, the modifying influences of other pioneer forest stands diminish the significance of soil texture and allow other species to succeed on soils with a relatively low content of the fine soil material.

Significance of Soil Texture in Forest Planting

In artificial reforestation, the soil of a cut-over or burned-over area has no protection from wind and sun rays. Such soils lack, as a rule, the protective layer of mulch, as well as humus. Their readily available nutrients are leached away by rains which fall on the exposed barren surface. Under these conditions, the fine soil material becomes the decisive factor in the successful establishment of planted seedlings. As observations show, in reforesting well drained Wisconsin soils the most important species require for a fair growth the following minimum amount of the fine soil material: jack pine, 5 per cent; Norway or red pine, 10 per cent; Scotch pine, 10 per cent; white pine, 15 per cent; red oak, 25 per cent; white spruce, Norway spruce, and most of the hardwoods, 35 per cent.[2]

On the basis of these data, the simple

Table 1

Percentage of fine material	Soil class	Reforestation possibilities
Less than 5	Coarse sand	No profitable reforestation except in cases of wind erosion control. Russian olive and black locust.
5—10	Medium sand	High light-demanding pioneer species, chiefly jack pine and black locust.
10—15	Fine sand	High and medium light-demanding pines, chiefly Norway pine, Scotch pine, and jack pine.
15—25	Sandy loam	All pines, including tolerant species such as white pine.
25—35	Light loam	Hardwoods and conifers with medium requirements for moisture and nutrients, such as red oak, yellow birch, white pine, and European larch.
35 or more	Heavy loam	Conifers and hardwoods with high requirements for moisture and nutrients, such as white and Norway spruce, European fir, white ash, elms, basswood, beech, oaks, walnuts, and hickories.

[2]The data cited in this paper refer to the fine soil material, determined by the method described farther on.

classification of textural soil types (Table 1) has been adopted for use in the local reforestation practice.

It should be understood that the planting possibilities depend not only on soil texture, but also on a number of other factors, such as exposure, ground water level, chemical composition of soil, particularly soil reaction, etc. The choice of species and their adaptation to different soil types also varies greatly with different climatic conditions. Therefore, the knowledge of planting possibilities in other regions is a matter of local experience, derived from observations of both the natural distribution of trees and the conditions in artificial plantations.

Importance of Soil Texture in Cuttings and Thinnings

A knowledge of soil texture is essential in all silvicultural operations, especially in thinnings and selective cuttings, since it greatly affects the intensity of cuttings and the choice of species which should be protected. For example, it would not be profitable to improve by cutting an oak stand on soil which has less than 20 per cent of fine material, because the oak on such soil will not produce a satisfactory yield of timber. The only cutting which might be expected in this case would be for underplanting the area with pine species.

In cutting for the underplanting, it is again necessary to consider the soil texture. The heavier the soil, the greater is the danger of excessive growth of competing ground vegetation when sufficient light is available. Hence, a denser canopy of the thinned stand should be maintained in order to control the competition of weed species. For instance, an oak stand on soil containing 10 per cent of fine soil material may be thinned as much as 80 per cent of the normal density for the purpose of underplanting with pines; but an oak stand on soil having 30 per cent of fine soil material should be thinned not more than 40 per cent of the normal density in underplanting with spruce.

The Importance of Soil Texture in Forest Nurseries

The nursery soil must have a sufficient amount of nutrients so that the seedlings do not suffer from undernourishment. Also, the nursery soil must have a fairly high water-holding capacity; otherwise the seedlings suffer from extremes in moisture content, even in nurseries with artificial watering. To satisfy these requirements, the nursery soil should have a rather high content of fine particles. At the same time, nursery soils with too high an amount of fine soil material are subject to heaving or freezing out of seedlings, owing to their excessive saturation in the periods of fall and spring frosts. Also, the seedlings on heavy nursery soils suffer greatly through the breaking of the roots during the spring transplanting, since heavy soils often remain frozen at this time. In view of these facts, the most desirable content of fine soil material of nursery soil ranges from 15 to 25 per cent.

The application of commercial fertilizers in the form of mineral salts is at present a common practice in maintaining the fertility of nursery soils, particularly those of a sandy nature. Unfortunately, in applying fertilizers, as a rule too little attention is being paid to the fact that the introduced salts must be balanced in the soil by a certain amount of colloidal material.

If mineral fertilizers are applied to soils with an insufficient content of fine material, they remain unabsorbed by the soil. A considerable portion of the unabsorbed fertilizers is soon washed out of the soil by rains or artificial watering, while the remainder, being in free solution, often is more detrimental than

beneficial to the seedlings, because of chemical injury to their roots. A thorough mixing of the fertilizers with the soil may prevent, to a certain extent, the chemical injury to the young roots. Yet only colloidal material provides the proper exchange reactions of fertilizers in the soil, and facilitates their assimilation by the seedlings. This is especially true during the first period of seedling growth. Figure 1 illustrates the influence of direct application of a complete nitrogen-phosphorus-potash fertilizer to a sandy soil, and of the same fertilizer buffered with colloids (7).

The rate of fertilizer application varies considerably, depending upon the chemical composition of the nursery soil. Therefore, only a very general relationship between the amount of mineral salts to be applied and soil texture may be established. If nursery soil has less than 15 per cent of the fine soil material, no mineral fertilizers should be applied directly. At a content of fine soil material ranging from 15 to 20 per cent, only a light direct application of mineral fertilizers can be beneficial. Such an application should not exceed 200 to 250 pounds per acre of total mineral salts. Finally, a fairly heavy direct application, reaching 500 to 700 pounds per acre of total salts, may be made on soils having 25 per cent or more of fine material. In all cases when the content of the fine soil material is too low for the required treatment, the soil must be artificially enriched in fine soil material by the addition of clay, peat, or forest mulch; or the fertilization must be accomplished in the form of a compost.

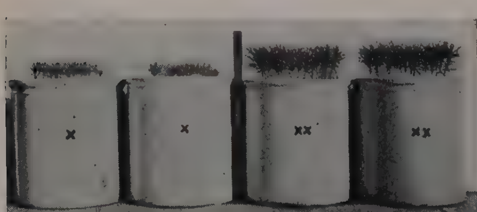

Fig. 1.—Norway pine seedlings, 6 months old, grown on sandy soil treated with a complete fertilizer (x) and the same seedlings grown on soil treated with complete fertilizer plus colloidal material (xx).

Method of Determining Soil Texture

The recent extensive reforestation program has directed many foresters into soil work, particularly in selecting planting sites, acquisition of land, appraisal of tracts under forest crop law, etc. Since these foresters often have had but little experience in soils, particularly in the determination of soil texture, the need for a simple and quick test for this soil property becomes especially important.

At the present time, the hydrometer method, devised by Bouyoucos (1, 2), is the most suitable for forestry practice. Yet the price of the standard equipment, its weight, and the need of an electric current limits its use in field work. Because of this, the following adaptation of the standard hydrometer method is suggested for field use.

The soil is separated from gravel and other coarse material by passing the soil through an 18-mesh sieve, onto a piece of ordinary paper. A sample of approximately 40 grams of sieved soil is taken with a measuring spoon. Special attention should be given to filling the measuring spoon completely by packing the soil and then striking off just level full with a spatula. The sample is placed in a 125 cc. flask with a wide neck and approximately 1 gram of dispersing agent (sodium oxalate) is added, using a small measuring spoon that is filled level full. The flask is filled with water up to the 100 cc. mark. A rubber stopper is inserted and the flask is shaken vigorously back and forth 60 times by hand and then placed on a level surface. After exactly one minute, a tube 5.5 inches high and one inch in diameter is filled with some of the suspension to the

60 cc. mark. A small, specially calibrated hydrometer is immediately floated in the suspension in the tube, and the reading is taken as soon as possible.

The maximum amount of the fine soil material which can be read on the scale is 35 per cent. If a content higher than 35 per cent is to be determined, one half of the normal amount of soil should be used in the analysis, and the results multiplied by two. The samples of very heavy soils should be left over-night in the shaking flasks, with water, to help in the dispersion of colloids. Under ordinary conditions, however, the percentage of fine soil particles higher than 35 per cent has no special significance to the practical forester.

Since the temperature and quality of water used in analysis affects to a certain extent the hydrometer reading, the hydrometer, before analysis, should be placed in the test tube with pure water to check whether or not the water level and zero mark of the hydrometer correspond. In case the zero mark is higher or lower than the water level, the difference must be subtracted from or added to the final reading. The difference due to temperature and quality of water does not exceed two divisions of the hydrometer scale.

In analyses it should be remembered that forest soils are not always uniform throughout the profile, and hence, the soil to the depth of about 4 feet should be carefully examined as to the distribution of the fine soil particles. First, the amount of the fine soil material must be determined in the upper soil layer. This layer serves as a growing medium during the critical early period of seedling growth, and is especially important in nursery soils as the chief carrier of fertilizers.

If the soil grades with depth into coarser material, this will not have any detrimental influence upon the growth of seedlings in the nursery, but it is wise in such a case to be rather conservative as to the selection of species for planting. For instance, if a surface sandy loam layer is only 8 inches deep and grades into sandy subsoil, it is better to plant on such a soil, in Wisconsin, red pine instead of white pine. Similarly, heavy loam soil of about 12 inches in depth underlain by stratified sand and gravel should be reforested to white pine rather than to hardwoods or spruce.

If the upper soil layer grades into heavier material, it may be detrimental in nursery soils because of excess of water in the spring. In planting, however, a heavier layer occurring at a depth of from 1 to 2 feet determines quite largely the supply of water and nutrients, since the roots of planted seedlings will reach this layer in a short time. Consequently, the amount of the fine soil material in this layer will determine the selection of species for planting. If a heavier soil layer occurs at a depth of 2 to 4 feet, it will still have a pronounced influence upon the growth of seedlings.

Of course, this influence will vary, depending on the depth of the heavier material, textural composition of the entire profile, and the age of the plantation. Therefore, in dealing with soils of this kind, no definite rule can be given, but in general, a heavier subsoil layer allows for more freedom in the selection of species for planting.

For instance, if a light loam soil is underlain at a depth of three feet by heavy glacial till, spruce may well be planted instead of white pine. On the other hand, a pure sandy soil underlain at a depth of 4 feet by a layer of clay cannot be reforested with spruce, but at best with the better pine species, since it will take a number of years before the roots of the seedlings will be able

to utilize the capillary water as well as nutrients of the heavy clay subsoil.

It is understood that in sampling, the genetic nature of soil and the horizon variation must also be considered, and samples taken accordingly (6). Especially, the fact should not be overlooked that some subsoil layers may be detrimental to seedlings, either because of high concentration of salts (podzol, rendzinas), or because of very high content of colloids, which in dry seasons cut off the capillary movement of ground water (claypan, strata of weathered shale, etc.).

The test described has been calibrated on the basis of a study of the soils from more than one hundred different forest stands and plantations over the State of Wisconsin. Quadruple checks with different soils, run by four different persons, have shown that this test gives reliable data within the broad limits required in forestry practice.

The complete testing outfit can be obtained from the Central Scientific Company, Chicago, Ill.

The author is indebted to Professor A. R. Whitson, Chairman of the Soils Department, and to the members of the Wisconsin Conservation Department for their helpful suggestions.

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CARRYING CAPACITY OF TIMBER OPERATIONS FOR SUSTAINED YIELD

By E. T. F. WOHLENBERG

In this article two problems are discussed which are of importance in the working out of a sustained yield plan of management for an individual operation: first, how much timber the operator can afford to carry; second, what is the effect of taxation on the timber carrying capacity of the operation.

ARTICLE X of the Lumber Code has turned the thoughts and energies of many foresters and lumbermen toward sustained yield plans. The Forest Service has some of its members working on plans for large units, such as states or regions. These plans are of great importance as a basis for arriving at sustained yield forest management for smaller units.

The state or regional plans will not be of much value unless the work is carried through to individual operations. Unless the individual operator can be sold on the idea, the large basic plans will lie dormant and nothing will be accomplished.

When sustained yield is examined from the standpoint of the individual operator, a number of important problems are brought up. These problems will be difficult of solution, and methodology of some kind will have to be worked out to arrive at a reasonable answer.

In working out a sustained yield plan for an individual operation, the first and most important problem which arises is what quantity of timber the operator can afford to carry. If too much timber is carried, the operator goes broke and the plans are disorganized. If too little timber is carried and the government makes purchases of sufficient timber to round out a sustained yield unit, an unjust subsidy is granted. In this connection it will also be necessary to determine the effect of taxation on the timber carrying capacity of an operation. If sustained yield is to be maintained, the relative effects of the present property tax and the severance tax, which is better adapted to sustained yield, will be of importance in those states which are anxious to stimulate sustained yield management.

In this article the two problems mentioned will be discussed; first, the timber carrying capacity of an individual operation, and second, the effect of two systems of taxation on timber carrying capacity. A method will be suggested which may be used to arrive at a reasonable answer for an individual operation.

The source of all life and activity in a sustained yield operation is the net income which can be derived from each thousand board feet of timber products manufactured annually, over a period of years. In order to arrive at the return to the stumpage, the net back to stumpage plus the taxes paid must be determined on an operation for at least the last 20 years, and preferably for 30 years or more.

The net back to stumpage is determined by taking the net income, plus the depletion, plus interest paid, plus any losses sustained not incident to the lumber operation, minus interest received and minus profits received not incident to the lumber operation. In this instance taxes paid on timber must also be included. The result should be divided by the quantity of timber cut, which will give the average net back to stumpage, plus taxes, per thousand board feet. This calculation will give a picture of the past.

In projecting what the net back to stumpage plus taxes will be in the future, the conditions of the operation must be

taken into consideration. Interest rates will probably be less and profits tend to be smaller. Selective logging, however, will tend to increase returns over the old systems of logging. All information, such as financial conditions, logging conditions, operating conditions, etc., should be obtained, and from this a reasonable figure for future net back to stumpage, plus taxes, can be arrived at.

In Table 1 the net back to stumpage plus taxes, set up as an example, is $6 per M. In the period before the depression, figures from 40 to 60 per cent higher were not unusual on large operations for from 20 to 30 years in the past. In the years to come a smaller cut and more government regulation will tend to decrease profits, while lower interest rates and selective logging may have a somewhat compensating effect. An operation on sustained yield will automatically reduce depreciation charges on the more permanent structures, which in turn will increase the net back to stumpage.

After the net back to stumpage is determined it is necessary to arrive at a fair return of theoretical interest on the investment in timber. The interest rate which should be used is apt to be a subject of much controversy. With sufficient information of the conditions of the operation, it is believed a fair rate could be determined. In case the government or the state wishes to stimulate sustained yield and round out the timber units necessary to carry an operation through a rotation, the interest allowable on the investment, as well as the value of the timber, can be more or less dictated. From present indications, the interest rates for the future will be less than they have been in the past.

When the above figures have been determined, a table can be set up from which a fairly accurate forecast can be made as to the timber carrying capacity of the operation under consideration. All the figures in Table 1 are in relation to each thousand board feet cut annually;

TABLE 1

TABLE TO DETERMINE TIMBER CARRYING CAPACITY

Annual cut	[1]Supply of timber carried per M of annual cut	Cost or value of stumpage at $2 per M	Property tax at 3 cents per M	Theoretical interest allowed on holdings at 5 per cent	Net back to stumpage plus taxes determined	Net return
1M	5M	$10.00	0.15	0.50	$6.00	$5.35
1M	10M	20.00	0.30	1.00	6.00	4.70
1M	15M	30.00	0.45	1.50	6.00	4.05
1M	20M	40.00	0.60	2.00	6.00	3.40
1M	25M	50.00	0.75	2.50	6.00	2.75
1M	30M	60.00	0.90	3.00	6.00	2.10
1M	35M	70.00	1.05	3.50	6.00	1.45
1M	40M	80.00	1.20	4.00	6.00	0.80
1M	45M	90.00	1.35	4.50	6.00	[2]0.15
1M	50M	100.00	1.50	5.00	6.00	—0.50
1M	55M	110.00	1.65	5.50	6.00	—1.15
1M	60M	120.00	1.80	6.00	6.00	—1.80
1M	65M	130.00	1.95	6.50	6.00	—2.45
1M	70M	140.00	2.10	7.00	6.00	—3.10
1M	75M	150.00	2.25	7.50	6.00	—3.75
1M	80M	160.00	2.40	8.00	6.00	—4.40
1M	85M	170.00	2.55	8.50	6.00	—5.05
1M	90M	180.00	2.70	9.00	6.00	—5.70
1M	95M	190.00	2.85	9.50	6.00	—6.35
1M	100M	200.00	3.00	10.00	6.00	—7.00

[1]The supply of timber is equivalent to the number of years of cut. 20M = a cut of 20 years.
[2]Carrying capacity 45 years.

these figures are simply given as an example.

From the above table, which is at a low stumpage cost and a low interest return, the limit of carrying capacity would be a 45-year supply. If the stumpage rate were $4.00 instead of $2.00 per M, the carrying capacity on a net back to stumpage plus taxes of $6.00 would be reduced to 25 years. Changes in the cost of timber and the net back to stumpage plus taxes of different operations would have a corresponding effect in the carrying capacity of the operation.

If an 80-year rotation were necessary in an operation for sustained yield and the operator had a carrying capacity of 45 years, it would be necessary for a public agency to carry a 35-year supply of timber in order to carry out the sustained yield plan. The public agency would have to carry this timber until the operator had decreased his supply to a point where he could take over the supply being held for his operation. After one complete rotation had been completed, and the second rotation was started, the holdings would be made up of a small amount of mature timber and a large amount of second growth and young trees, which could be carried by the operator as the taxes and the investment would be very much less.

Sustained yield plans will bring up many questions in regard to methods of taxation. Where the government carries part of the timber for a sustained yield operation, it will be necessary to coördinate taxation of timberlands with taxes of other property in the governmental unit to obtain the necessary revenue.

A state which wishes to stimulate sustained yield might recommend a severance tax in place of the property tax. A severance tax would be better adapted to sustained yield and would tend to increase the carrying capacity of an operation on a long rotation. The effect of a severance tax in lieu of a property tax could be determined by making a comparison of a severance tax with the results of Table 1, which is on a property tax basis. Using the same set-up as in

TABLE 2

TABLE TO DETERMINE EFFECT OF TAXATION

Annual cut	Supply of timber carried per M of annual cut	Net back to stumpage plus taxes	Property tax at 3 cents per M	Severance tax at 75 cents per M	Difference	Net return per Table 1	Revised net return
1M	5M	$6.00	0.15	0.75	—0.60	$5.35	4.75
1M	10M	6.00	0.30	0.75	—0.45	4.70	4.25
1M	15M	6.00	0.45	0.75	—0.30	4.05	3.75
1M	20M	6.00	0.60	0.75	—0.15	3.40	3.25
1M	25M	6.00	0.75	0.75	0.00	2.75	2.75
1M	30M	6.00	0.90	0.75	plus 0.15	2.10	2.25
1M	35M	6.00	1.05	0.75	0.30	1.45	1.75
1M	40M	6.00	1.20	0.75	0.45	0.80	1.25
1M	45M	6.00	1.35	0.75	0.60	0.15	0.75
1M	50M	6.00	1.50	0.75	0.75	—0.50	0.25
1M	55M	6.00	1.65	0.75	0.90	—1.15	—0.25
1M	60M	6.00	1.80	0.75	1.05	—1.80	—0.75
1M	65M	6.00	1.95	0.75	1.20	—2.45	—1.25
1M	70M	6.00	2.10	0.75	1.35	—3.10	—1.75
1M	75M	6.00	2.25	0.75	1.50	—3.75	—2.25
1M	80M	6.00	2.40	0.75	1.65	—4.40	—2.75
1M	85M	6.00	2.55	0.75	1.80	—5.05	—3.25
1M	90M	6.00	2.70	0.75	1.95	—5.70	—3.75
1M	95M	6.00	2.85	0.75	2.10	—6.35	—4.25
1M	100M	6.00	3.00	0.75	2.25	—7.00	—4.75

Table 1, with a property tax of 3 cents per M and a severance tax of 75 cents per M, the results, shown in Table 2, would be obtained.

From Table 2 it can be seen that the timber carrying capacity of this sample operation would be increased between 7 and 8 years, due to a change in the method of taxation. If under a severance tax the operator would be inclined to carry more timber than indicated, the interest charges, whether real or theoretical, would sooner or later get the operation into difficulties. By keeping the operation on an anual return of simple interest, the compound interest feature is eliminated. This method is well adapted to sustained yield, where the cut will tend to be constant annually.

Under the severance tax the operator who owns a small quantity of timber, say from ten to twenty years' supply, would pay a greater tax per M feet of cut than the large timber holder. The small timber holder could not practice sustained yield anyway, so he might just as well remain on the property tax basis. The large holder would gain an advantage through a severance tax. This would be justified on the ground that sustained yield would be carried out and a permanent operation would be established.

Net back to stumpage is calculated on the assumption that the plant is maintained and liquidated through maintenance charges and depreciation. In case sustained yield plans are set up, it is quite likely that depreciation per M feet of cut will be decreased. Permanent structures and main-line railroads would be depreciated at a smaller rate. A depreciation of $3 per M might be decreased to $2. The difference of $1 per M would in turn increase the net back to stumpage by this amount.

The above suggestions are not considered perfect by any means. It is believed that methods similar to the above will have to be developed in order to settle many of the perplexing problems which will arise in sustained yield operations. It is hoped that the above suggestions will stimulate some thought along this line.

THINNING LOBLOLLY PINE IN EVEN-AGED STANDS

By HENRY BULL

Southern Forest Experiment Station, U. S. Forest Service

Second-growth or old-field southern pine stands are frequently very dense, with the individual trees so badly crowded that their rate of growth is very slow. This actual stagnation of growth brought about by intense competition, however, can usually be avoided or corrcted by a thinning, made for the specific purpose of increasing the growth of the remaining trees. The two-fold object of increasing the rate of growth is to hasten the production of merchantable products from selected trees and to increase the total yield of the stand. In practice, a thinning generally includes also the removal of trees of undesirable species or form and trees that would otherwise die before another cutting.

Thinnings are highly desirable from a silvicultural standpoint in fully stocked or overstocked stands or groups of trees, and in this connection it should be noted that stands understocked on the whole are often fully stocked or overstocked in small groups. But good silviculture is not necessarily good economics, and to a forest owner the economic aspect necessarily carries the most weight. In the following discussion, the economic aspect of thinnings is given full consideration.

A THINNING is only a means to an end. This is important to keep in mind because the desired end-product should largely determine the nature of the thinning. Even with the desired end-product clearly in mind, however, the best or most appropriate method of thinning cannot be determined without consideration of such additional factors as the market or possible local use of material removed in the thinning, the financial status of the forest owner, and the attitude of the owner toward the use of his land for forestry. Before thinning is begun, the owner should have a definite idea of exactly what is desired, why it is desired, and how the stand should appear when the operation is completed.

Since all fully stocked or overstocked stands of trees are potentially in need of thinning, the practice is applicable wherever such stands occur. Each commercial species or forest type of commercial value, however, presents special individual problems and is best adapted to special methods of treatment. In this article, the discussion is limited to loblolly pine growing in even-aged stands in the shortleaf-loblolly pine-hardwood forest, which occupies about 76 million acres in Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Oklahoma. A very small percentage of this widespread forest consists of even-aged, second-growth loblolly pine, but the total acreage of such stand is large.

The Southern Forest Experiment Station has established and maintained a number of experimental thinnings near Urania, LaSalle Parish, La., and many of these have been under way long enough to indicate what may be expected from different methods of thinning in second-growth stands of various ages. The experimental thinnings from which tentative conclusions can be drawn are confined to even-aged, old-field stands. The following discussion applies directly to such stands, and in a general way to all even-aged stands, whether old-field or not.

Old-field stands usually start as dense stands of small seedlings with densities ranging up to several thousand per acre. There is great variation in the number of seedlings that become established, but the stands most in need of thinning usually start out with well over 2,000 seedlings per acre. The average development of old-field loblolly in unthinned, well-stocked to overstocked stands is illustrated in Table 1.

This table shows a tremendous mortality between 10 and 60 years, but the rate of mortality is not sufficiently rapid to prevent a serious stagnation of growth. This indicates that natural thinning should be supplemented by artificial or man-made thinning. The thousands of small original seedlings grow rapidly until their crown and root systems meet and begin to interlock and interfere with one another. After the stand has closed there is intense competition for both light and soil moisture. The competition is the more intense and injurious to individual trees because it takes place between trees of approximately the same size, with similar crowns and root systems. This results in the sudden slowing down of the fast early growth typical of old-field stands. The growth rate continues to decrease sharply unless or until the proper kind of thinning is made. It should be clearly understood in this connection that not just any kind of thinning will improve the growth rate.

The emphasis so far has been placed on the fact that thinnings do or should increase the growth rate of the remaining trees. This seems justified on the ground that the average forest owner would not otherwise be interested in thinning. However, something should be said in behalf of the light thinnings that usually do not increase the growth rate, although they do remove trees of poor form, quality, or species, diseased and unhealthy trees, and trees that would otherwise die through suppression and crowding before the next cutting. If the material thus removed can be utilized to advantage locally, or sold at no loss, such thinnings are entirely desirable. It is only when the cut material cannot be utilized that these thinnings become merely a waste of time and money, since they improve the growth of residual trees only slightly, if at all.

The principal silvicultural problem involved in thinning is to increase the growth rate of the remaining trees by an appreciable amount without cutting too many potentially merchantable trees. On the one hand it is difficult to increase the growth with a light thinning, and on the other hand it is difficult to make a heavy thinning that will increase the growth rate of individual trees, yet not result in a decreased final yield of the whole stand. For example, consider two good 7-inch trees, growing about 6 feet apart and with practically no other competition. Shall we cut one out, or shall we leave both? By cutting one, we can certainly increase the growth of the other, but how much? Will it increase sufficiently in growth to make up for the fact that in the future only one crop tree can be harvested instead of two? Two 17-inch trees, for example, will usually contain about 25 per cent more lumber than one 20-inch tree, but about 5 per cent less lumber than one 23-inch tree. The decision depends on the expected increase in

TABLE 1

TYPICAL DEVELOPMENT OF AN OLD-FIELD STAND OF LOBLOLLY PINE

Age	Approximate range in number of trees per acre	Average number of trees per acre	Approximate range in diameter breast high	Average diameter breast high	Average mortality in number of trees in 5 years after given age
Years			Inches	Inches	Per cent
10	1,500-4,000	2,200	0- 6	2	45
20	550-1,200	800	2-11	6	28
30	250- 700	420	3-16	8	19
40	150- 450	280	3-20	10	14
50	120- 300	205	4-23	12	12
60	100- 250	160	4-25	13	8

rowth, the size of timber desired, and he attitude of the owner as to when he lesires to make the final cutting. The nain silvicultural problem, then, is to ind the happy medium between too light hinnings that do no good and too heavy hinnings that defeat their own purpose. Additional silvicultural problems have to lo with the production of the highest quality of material and the gradual de- elopment of conditions suitable for re- producing the stand naturally.

The principal economic problem is to nake the thinning pay. This does not necessarily mean obtaining an immediate ash profit, for a present expense may often be converted into a future profit. The economic justification of thinning de- pends on a number of factors, many of which cannot be accurately estimated or predicted. Among these are the financial tatus of the owner, the market value (if any) of the removed material, the prob- able future market for the products to be grown, and the location and accessibil- ty of the stand.

This paper presents a set of specific ecommendations and conclusions based on analysis of the available experimental ata. The recommendations may be changed omewhat with further experimentation. For convenience and conciseness they have been arranged in tabular form and are presented in Table 2. A summary of tentative conclusions derived from the experimental work in northern Louisiana o date is also given.

Recommendations for Thinning Even-Aged Loblolly Pine, Either Pure or in Mixture with Shortleaf Pine and Hardwoods

The nature of the thinning recom- nended to be made in any specific stand s considered to be largely dependent on hree factors: (1) the market conditions and the market or utilization value of the hinned material; (2) the wishes and plans of the owner with reference to the end-products desired and the length of time he is willing or can afford to wait; and (3) the extent to which the dominant trees are clear of live branches (a convenient single factor that reflects the combined influence of age, size, site, and stocking).

The recommended thinning practices summarized in Table 2 represent a compromise between two radically different practices, each of which has special advantages and disadvantages. The first consists of very early and very heavy thinnings, which require an immediate cash outlay since there are usually no merchantable products in the small trees that are cut, but which are likely to result in the greatest ultimate yield in the shortest time. The second practice consists of late or delayed thinnings, which produce the highest immediate profit but generally have little beneficial effect on the rate of growth of residual trees. The compromise is made in the belief that the combination of some immediate profit and some increased growth is usually most desirable to the average timber owner.

The recommendations are for first thinnings and presuppose the possibility of additional later thinnings. No recommendations are made for stands in which the dominant trees have dead branches or are clear for less than 17 feet (one log length), due to the lack of sufficient experimental data.

Table 2 is divided into three parts, according to the existing or potential markets for the trees cut in thinning:

Part A.—Assuming a market for pulpwood or other small material, or that the trees can be used to advantage for firewood, etc.

Part B.—Assuming no immediate market or use for the thinned material, but that there is reasonable hope for a future

Table 2

RECOMMENDED THINNING PRACTICE FOR FIRST THINNINGS

Part A.—Assuming a market for pulpwood or other small material, or that the trees can be used to advantage for firewood, etc.		
Wishes and plans of owner	Stands in which dominant trees are clear or have only dead branches for an average length of 34 ft. or more (i.e., at least two logs).[1]	Stands in which dominant trees are clear or have dead branches for an average length of only about 17 ft. (i.e., one log).[1]
	RECOMMENDATIONS	
Saw timber alone is desired and as soon as possible.	Leave best 30-80 trees per acre (average spacing 23-38 ft.); cut practically everything else, except small trees in openings. In general, leave all trees 5 inches d.b.h. or less when they are not directly interfering with the crown development of the best or crop trees.	Leave best 100-140 trees per acre (average spacing 18-21 ft.); cut practically everything else, except small trees in openings. In general, leave all trees 5 inches d.b.h. or less when they are not directly interfering with the crown development of the best or crop trees.
Saw timber alone is desired, but maximum volume and highest quality are preferred to an early return.	Leave best 80-120 trees per acre (average spacing 19-23 ft.); cut practically everything else, except small trees in openings. In general, leave all trees 5 inches d.b.h. or less when they are not directly interfering with the crown development of the best or crop trees.	Leave best 160-200 trees per acre (average spacing 15-17 ft.); cut practically everything else, except small trees in openings. In general, leave all trees 5 inches d.b.h. or less when they are not directly interfering with the crown development of the best or crop trees.
Both saw timber and pulpwood are desired, and even relatively small quantities of each are salable.	Leave best 30-80 trees per acre (average spacing 23-38 ft.) for saw timber. These trees should be clean, straight, sound, and give promise of producing at least one No. 1 saw log. Leave all sound trees less than 6 inches d.b.h. that are likely to remain alive until the next cutting. Cut all trees 6 inches d.b.h. and larger that will never produce at least one No. 1 saw log.	Confine thinning to removing trees directly interfering with the best 150-200 trees per acre (average spacing 15-17 ft.) or postpone the thinning until a later date.
Pulpwood alone is desired, and a more or less continuous sustained yield is to be achieved.	In stands averaging 11 inches or more in d.b.h., leave all sound trees below 9 inches d.b.h., and also leave one 10-inch or better tree per quarter-acre as a seed tree (average spacing 105 ft.). In stands averaging about 8 inches d.b.h., leave about 200 sound 6 to 9-inch trees per acre (average spacing 15 feet) and all sound trees 5 inches d.b.h. or less that are likely to remain alive until the next cutting. In stands averaging 5 inches or less d.b.h., no thinning is recommended. Wait until pulpwood can be removed. If, however, there are a number of trees 6 inches and more d.b.h., these should be thinned out.	
Part B.—Assuming no immediate market or use for the thinned material, but that there is reasonable hope for a future market for small material within about 10 years.		
Under this condition, no immediate thinnings are recommended. Wait for a market or use for the cut material to develop, and then thin according to Part A, above.		
Part C.—Assuming no immediate market or use for the thinned material and that there is no likelihood of a market within the next 10 years.		
Wishes and plans of owner	Stands in which dominant trees are clear or have only dead branches for an average length of 34 ft. or more (i.e., at least two logs).[1]	Stands in which dominant trees are clear or have dead branches for an average length of only about 17 ft. (i.e., one long).[1]

[1] For intermediate conditions, assume intermediate or compromised recommendations.

TABLE 2 (*Continued*)

	RECOMMENDATIONS	
Saw timber alone is desired and as soon as possible.	Leave only best 30-80 trees per acre (average spacing 23-38 ft.) or make no thinning at all.	Leave only best 100-140 trees per acre (average spacing 18-21 ft.) or make no thinning at all.
Saw timber alone is desired, but maximum volume and highest quality are preferred to an early return.	Leave only best 80-120 trees per acre (average spacing 19-23 ft.), or make no thinning at all.	Leave only best 160-200 trees per acre (average spacing 15-17 ft.), or make no thinning at all.
Pulpwood alone is desired, and a more or less continuous sustained yield is to be achieved.	No thinning recommended. Wait for market to develop.	No thinning recommended. Wait for market to develop.

market for small material within about 10 years.

Part C.—Assuming no immediate market or use for the thinned material, and that there is no likelihood of a market within the next 10 years.

TENTATIVE CONCLUSIONS AND OBSERVATIONS DERIVED FROM EXPERIMENTAL THINNINGS IN NORTHERN LOUISIANA

1. Good sites offer far greater possibilities of beneficial effects from thinning than do poor sites. Thinning should be concentrated on good sites.

2. Light and medium thinnings that remove only the smaller, more suppressed, slower-growing, more poorly situated, or dying trees do not appreciably increase the growth rate of the remaining trees beyond that usually obtained in unthinned stands. Heavy thinnings that remove the same classes of trees increase the growth rate of the remaining trees only slightly. Thinnings that remove only the poorest, smallest trees seem unlikely to be of practical benefit except to the extent that they remove usable or salable material that would otherwise be lost through death and decay.

3. Thinnings that remove trees competing directly with selected "crop trees," regardless of the size or vigor of the competing trees, increase the growth of the selected crop trees if made heavy enough and early enough. It is difficult to secure a degree of thinning around selected crop trees that is both silviculturally and economically sound, and from the experimental work to date it is impossible to draw very specific conclusions. It is probable, however, that moderate to heavy crop-tree thinnings are generally beneficial and practical, especially when the crop trees are badly crowded and there is a good market for the material to be removed, or when there are many very poor trees of the larger sizes in the stand.

4. Thinnings have the most marked beneficial effect on the growth rate of the remaining trees when made very early in the life of a stand. Too early thinnings, however, remove trees that in a short time would be of pulpwood or post size. If there is a market for pulpwood, posts, or similar small products, thinnings should be deferred a few years beyond the time when they are likely to have the greatest silvicultural effect. With no market for small products, and no other use, thinnings should be begun when the dominant trees are about 3 to 6 inches in diameter breast high (about 10 to 15 years old). With a market for small products, the first thinnings should be made when the dominant trees are about 6 to 9 inches in diameter breast high (about 15 to 25 years old.) Even where there is no use or market for the

trees to be cut, stands destined to produce saw timber should either not be thinned until the dominant trees have pruned themselves at least for one log length (17 feet), or selected crop trees should be pruned at the time of thinning. Although very little is known of the costs, results, or practicability of pruning loblolly pine, it is likely to be very profitable in many instances. Very early and very heavy thinnings in loblolly pine, with pruning of relatively few selected crop trees, have not been investigated to date, but they offer considerable promise and experiments along this line will soon be initiated. Despite their initial expense they may prove to yield the highest ultimate net return.

5. Thinnings need not remove large volumes of wood per acre in order to pay an immediate profit. A recent study showed that with readily accessible stands and a good market for pulpwood, removal of but one-fourth of a cord per acre actually returned a net profit over all costs. It is usually neither practicable nor desirable to remove such small volumes as this, but it serves as an example of what can be done.

The wide and sandy road towards Oaxaca was very busy the day I rode over it. Men and women trotted along it on foot, others were mounted on burros, mules or horses, and covered ox-wagons with solid wooden wheels slowly rolled along, creaking and squeaking. Inside sat men and women, dressed in their best and making merry, playing guitars and singing songs of the region. Alongside the road were stalls where food and drink were sold. The reason for this unusual movement was that the annual "fiesta del tule" was held on that day. The tule is a famous old sypress tree which has stood for many generations in a village that derives its name therefrom. There are several of thse gigantic old trees in Mexico, but the one I saw here is the biggest I came across, and it is claimed that this cypress is over 5,000 years old. Once every year huge crowds assemble in this village for a fiesta that lasts two or three days.—*Tschiffely's Ride* by A. F. Tschieffly, 1933.

PRUNING AND THINNING A WHITE PINE PLANTATION IN THE SOUTHERN APPALACHIANS[1]

By E. M. SIMMONS

Junior Forester, Nantahala National Forest

This article describes the crew organization, tools used, and results obtained in a combined thinning and pruning operation in planted white pine on the Nantahala National Forest.

THIS project was undertaken with the objective of establishing a policy for future similar operations in the white pine areas of the Nantahala National Forest in North Carolina and Georgia. At the outset, very little information as to the amount to prune and thin was available. The Northeastern Forest Experiment Station supplied us with the information that it was considered safe to remove up to one-half the volume of the green crown of a white pine. This was the policy decided upon for the pruning. The only other instructions were that all brush must be piled. At the inspection made upon the completion of the job, this last order was rescinded; lopping and scattering being considered sufficient precaution.

The plantation was set out by the Forest Service in 1917, three year old stock being used, making the age at the time of pruning twenty years. The average height of the stand (estimated) was 35 feet, and the average diameter approximately five inches. The original spacing was 6 feet by 6 feet. The limbs were dead, though persistent, to an average height of eight feet, and very thickly intertwined, making the plantation almost impenetrable. Several borings were taken, showing a growth of one inch in radius during the previous five years.

The pruning tools used were of two kinds; a pair of heavy pruning shears, made by the Porter Company, capable of clipping a limb two inches in diameter. These shears were 30 inches long, built of strong heavy material and admirably suited to the work for which they were made. The tool has three adjustments, intended to give more leverage as it may be needed. The weight was 7 pounds. In the hands of a skilled user, this is one of the most effective tools for low pruning. The other tool was a long handled saw and clipper combined, made by the Bartlett Saw Company. The saw was of the curved blade type, cutting on the down stroke, which proved very efficient, especially in the higher limbs. The weight of the saw combined with the curved blade made sufficient downward pressure to cut through the limb. A few straight blade saws were tried, which proved effective in the lower limbs, but when the higher limbs were tried, it was found to be very difficult to bear down hard enough upon the handle to make the saw cut, especially when the end of the handle was above the head of the man using it. The clipper on the Bartlett saw was capable of cutting a limb up to 1¼ inches in diameter. The handles ranged from ten to sixteen feet in length.

We experienced one difficulty at first. It was noticed that when the pruned limbs fell, especially the heavier ones, there was a tendency for them to pull a strip of bark from the tree. Various

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[1]Acknowledgment is made to Mr. F. A. Albert, Assistant Supervisor, Nantahala National Forest, for his splendid coöperation in discussing the various problems as they arose.

methods to prevent this were tried. An under-cut on the limb made before the limb was entirely severed was effective, but owing to the curved saw blade, was very difficult to make where it would do the most good. Finally a successful method was hit upon. While sawing through the limb the man watched for it to start falling. As soon as it started, he stopped sawing until the limb hung down. As it fell, it invariably cracked at the point to which is had been sawed, leaving a stub attached to the tree from which the partly severed limb now hung. With a few swift strokes of the saw the stub could be sawed off and the limb would drop free without tearing the bark.

Inasmuch as the work was entirely new, a method of attack had to be developed. After trying various combinations, the one upon which I finally decided was as follows: the crew was divided into four-man units, these units worked side by side, but entirely independent of each other, except that each unit guided upon its neighbor for direction. Thus the work progressed from one side of the plantation, continuously back and forth, to the other. Within each unit, the head man carried one of the Porter tools, with which he clipped all the trees to be pruned to a height of eight feet. This man was followed, first by a man with a short handled saw (10 feet), next by a man with a long handled saw (16 feet) and finally by an axeman, whose duty it was to cut the trees to be removed, lop and pile the brush.

As the men became more expert with the tools, it became necessary to readjust these positions somewhat, as circumstances directed. For example: it soon became apparent that the brush pilers had so much more work in comparison, that is was impossible for them to keep up. After a bit of experiment, it was found that the head men, with the Porter tools, could clip enough trees by mid-afternoon to last the saw men the balance of the day. By taking these head men and putting them to help the brush pilers, the work could be kept caught up by the end of the day.

The original intention in thinning was to aim towards a 12 feet x 12 feet spacing for trees remaining, but due to a misunderstanding, I was not made aware of this. My policy in carrying out the work was to aim for a 10 feet x 10 feet spacing. This spacing was not adhered to absolutely, the best trees were always left, being marked with lime, indicating that these trees were to be pruned. Then those trees which were offering crown competition were marked with an axe blaze for removal. In addition, 90 per cent of the suppressed trees were removed as well as those intermediate trees which did not serve as trainers for the crop trees. The result was that practically all the trees which were not pruned were removed. After spending a few days with my foreman in showing him the method of marking, I was able to leave it in his hands, making an occasional decision for him. He preceded the crew marking both the trees to be pruned and those to be removed.

The entire plantation covered approximately nine acres. In all 16 working days were used to cover the plantation. The records show a total of 224 man days, making the average size of the crew 14 men. As all the labor was from the Civilian Conservation Corps, 6 hours constituted a working day. Unfortunately, no attempt was made to keep a separate record of the time allotted to pruning and to thinning, but of the 224 man days, approximately 100 can be charged to the thinning and brush piling. The work was done in January and February and much of the time freezing temperatures prevailed and snow covered the ground.

A total of 3,720 trees were pruned to an average height of somewhat over 16

feet, making 415 trees per acre. This number is in excess of the number per acre which will be standing at the time of maturity. However, with a species like white pine, with available markets, the excess trees can be removed in the future very profitably. Their value, I believe, will be sufficiently enhanced to more than pay for the present pruning.

It will be recalled, that this operation was undertaken to establish the policy to be followed, and it is well to note that it was decided to limit the number of trees pruned to approximately 300 per acre, on future operations.

Conclusions

In general, considering the circumstances, I believe the degree of pruning and thinning to be about right. The first reaction was that perhaps we had pruned too much, thus possibly retarding the growth for too protracted a period, but with the thinning as we have made it, there is plenty of room for the crowns to expand rapidly. Yet, on the other hand, nowhere are there any gaps so large that they cannot be filled by the remaining crowns within a few years. Naturally, one inevitable result of this type of procedure will be the formation of much heavier limbs for a few years immediately above the pruned area. As the average height of pruning was a little over 16 feet, there will be one log of clear lumber when the time of cutting comes. Contrasted to this policy, a lighter thinning and pruning could have been made which could have been repeated in the near future. This would have prevented the formation of the heavier limbs while the crowns were closing, but the diameter increase would have been slower. White pines growing adjacent to the plantation, under apparently similar site conditions, for the same age, showed an average diameter of eight inches, contrasted to five inches within the plantation, though they were much heavier limbed.

Thus the motive in back of a pruning and thinning operation as it was made in this case was to secure one log of clear lumber as rapidly as possible. The reason for this is clear when one considers that with the advent of the C.C.C., the Forest Service is in a position to improve thousands of acres of timber. On the Nantahala white pine is one of the more important species. If it were possible to state definitely that funds would be available within a few years, with which to continue this work, perhaps it would have been advisable to make a lighter pruning and thinning with the idea of securing more than one log of clear lumber per tree, but since this is impossible, it seems sensible to make as much improvement as possible with the one operation.

A project of this character offers a splendid opportunity for a little much needed research, and it is to be regretted that the funds allotted to research did not allow the Appalachian Forest Experiment Station to establish a few permanent sample plots, from which the degree of success of this operation could have been determined, and perhaps much light could have been thrown upon the method in which to make future prunings and thinnings in white pine.

I have one suggestion to offer for futrue similar work, namely: piling of the brush is unnecessary. As mentioned earlier, this policy of piling brush was discontinued in later projects. Due to the immense amount of brush, the piling of it, instead of reducing the fire hazard, actually increases it.

By the first of June there was very little evidence of bleeding among the pruned trees. In general, the limbs were small and will soon heal over. I do not believe the openings in the crown were large enough to endanger the trees from

sun scalding. I do, however, believe that close watch should be kept to guard against possible beetle infection. While the Nantahala has been exceptionally free from any serious insect attacks, one instance of beetle working in white pine was reported to me during the past year.

Where thinnings and prunings cannot be made at frequent intervals, I believe the method used in this operation should be given consideration in treating young stands of white pine.

Forestry Societies in Sweden

THE Swedish Forestry Society was founded in the year 1902. It was started at a time which for Swedish forest economy has been of far-reaching importance. The need of efficient protection and safeguarding of the country's forest resources and the establishment and creation of forest management, based upon native research, became more and more accentuated and resulted in a General Forest Act, applying to the private forests, and in the organization of the State Forest Research Institute. The interest in questions relating to forestry found expression in an endeavour to form by combination and coöperation a body which might be able actively to look after and further the development of forestry in the country.

The Norrlandian Forestry Union was founded in the year 1883. Its original aim and object was to stimulate interest in forestry, particularly in the northern provinces of Sweden, called Norrland, by organizing meetings and employing planters and instructors in silviculture for the purpose of assisting private forest owners. The Union had from the first another aim, namely, to provide the necessary forest seeds of a suitable nature for forest culture in Norrland, and to draw up statistics on forest cultivation and forest fires in that part of the country. In the year 1913 the Union was reorganized on a wider basis.

The "Skogssällskapet" (Forestry Society) is carrying on its work along lines that materially differ from those along which the two aforesaid societies or unions are working. The Forestry Society was founded in the year 1912, its chief task being the afforestation of such areas as have for a long time been deforested (heaths) or have of late years been the subject of mismanagement.—*Quarterly Journal of Forestry (English)*.

AFFORESTATION IN THE ANTIPODES

By L. MacINTOSH ELLIS

Sydney, Australia

NOW that there is so much discussion of the prairie Shelter Belt project, in which it is proposed to plant 1,500,000 acres at a cost of $75,000,000, perhaps some observations on large scale timber tree planting practice in the British Antipodes might be of interest to foresters in North America.

There are in Australasia nearly 900,000 acres of established exotic softwood plantations, of which 90 per cent have been formed since the Great War, at a cost of $25,000,000. Tree planting projects are being carried on by six states and two dominions; by a host of local governments such as shire councils and water boards, and incorporated companies; to say nothing of hundreds of individual planters. Of the total area about 47 per cent has been established by the state and local governments in New Zealand; 17 per cent by Australian state and federal capital authorities; 31 per cent by New Zealand and Australian incorporated industrial forestry companies; and 5 per cent by semi-governmental bodies in Australia. This relatively large planted acreage is not such a bad record for a people whose population is less than that of the State of Pennsylvania, and the first question that one asks is, "Why so much?" Many reasons may be given, but the paramount motivating force was the high prices paid for softwood products during the war and post-war period. The meagreness of softwood supplies from Scandinavian countries and from North America enabled those plantation owners who were fortunate enough to have groves or small plantations of exploitable Monterey pine to sell their stumpage at high prices, in some cases up to $2 per 100 feet board measure. These extraordinary returns induced individuals and governments to embark on large planting plans.

Remarkable cultural success had been attained in New Zealand, and to a lesser extent in southern Australia, with Monterey pine (*Pinus radiata*), and the planting of this tree was largely concentrated upon. The history of the introduction and acclimatisation of this species is obscure, but the available evidence indicates that it has been here for at least 100 years. No doubt seed was brought in by some whaler or in ship's ballast. In any event, this remarkable pine is now very widely diffused throughout Australasia and is "acclaimed by many technicians as being in a class by itself when it comes to producing plantation-grown softwoods at the lowest cost and in the shortest possible time."

The tree reaches relatively large dimensions; the writer has recorded specimens of 150 feet in height, 40 inches diameter breast high, at 40 years of age, carrying a merchantable volume inside bark of 2,000 feet board measure. On first site quality a mean annual increment of 500-600 cubic feet per acre is not unusual and a general regional m.a.i. of 250 cubic feet can be secured on fair to good site qualities. It attains its best development in New Zealand, where optimum growing conditions are to be found in localities at an elevation from sea-level to 1,000 feet, characterized by deep, rich pumaceous loams or well drained loamy gravels, rainfall from 30 inches to 50 inches annually, and with a general climate comparable to that of southern California. In general the Monterey pine

in Australasia yields wood goods of a quality quite acceptable for a wide range of building and general industrial needs and is in every way equal in use value to Baltic wood products, if not better.

The "timber famine" bogey has played not a little part in hastening large coniferous tree planting operations. It has been said that lack of knowledge of the silvics and silviculture of the indigenous eucalypt forests has retarded seriously the progressive regimentation of the natural wealth and fostered, on the contrary, the artificial propagation of exotic conifers. There is a popular conviction also in this land so abundantly endowed by Nature that the domestic woods grow too slowly; this however is purely relative. The proven value of forest cover in water and soil conservation and for farm shelter has greatly popularized substantial plantings of tree shelter belts, particularly in New Zealand, and many thousands of acres of such belts have been formed. It has been natural, too, for the farmers and pastoralists to take to tree planting, because inherently these folk have a very conscious and practical appreciation of the aesthetic and utility value of trees. At one time the State Forest Service of New Zealand carried on a very substantial business supplying shelter belt trees to farmers; in fact, from one nursery thousands of individuals were supplied, and the trees were not given away free, either.

Another and substantial, but more recent, *raison d'être* for tree planting has been that of finding work for the unemployed, for this means a 90 per cent expenditure in labor. It has been a traditional public activity in times of depression; in fact, the New Zealand Government first began its planting projects in the 90's in order to take care of unemployed, and during the last seven years thousands of men have been usefully employed on this work.

Why have the softwood conifers of North America and Europe been selected for mass planting rather than the excellent woods of demonstrated quality and value indigenous to these countries?

That is not a difficult query to answer when one remembers that Australia and New Zealand are comparatively young countries as far as European settlement is concerned, and their chief industries have always been those of pastoral and extensive farming pursuits. These two countries were settled largely during the Victorian era, and the free migration (practically entirely of British) consisted of a wealthy yeoman class and agricultural workers. These peoples, traditionally conservative, retained their English habits and customs to a very marked degree; and what was more natural than for them to continue to look to Scandinavia, for example, for their sawn wood goods rather than to use the so-called refractory eucalypts and the strange rain-forest timbers of New Zealand? The habit therefore of procuring much of their forest products abroad has greatly influenced the Australians and New Zealanders in desiring to assure themselves of supplies with which they are familiar. The species that best satisfied this demand for soft pine timber is the Monterey pine.

At least three-quarters of the plantations are planted in Monterey pine. As to the balance, a large number of other conifers from practically every part of the world are represented, including the following, in order of importance: Corsican, maritime, western yellow, southern pitch group, lodgepole, American white, prickly cone, Mexican, Canary Island, Aleppo, and insularis pines; Douglas fir, Sitka spruce, European larch, and a host of others. The writer is of the opinion that the selection will be narrowed down ultimately to about six species, including Monterey pine, corsican pine, western yellow pine, southern pines, with a lesser

representation including Douglas fir, lodgepole pine, white pine, and Bishop's pine.

The Dominion of New Zealand has outstripped all others in the dimension of its planting works, largely because of the ideal growing conditions prevailing there and because of the availability of large areas of treeless plains; and needless to say the planting technique has advanced to a very high state of efficiency. In the main, the lands selected have been Crown-owned areas, thus eliminating the land purchase costs. Lack of hindering vegetable growth has made it easy to lay out the planting program, to define the sub-divisions and compartments, and to proceed in a straightforward manner without interruption and costly preparation. In Australia the establishment conditions have been much more difficult, with the result that the forest unit areas are very much smaller. An example of a large plantation area in New Zealand is the Kaingaroa-Waiotapu State Forest, which covers a gross area of about 354,000 acres (and within an area of about 50 miles square in the same region there are nearly 600,000 acres of man-made forests). Across the Tasman Sea the planted units are much more widely scattered, averaging in size a few thousand acres. Establishment costs, which include seed, land clearing, topographic surveys and subdivision, tree stocks, camp organization, planting, road and boundary construction, superintendence, and planning, range from £4 per acre in New Zealand up to £15 an acre in Australia. Broadly, the mean establishment cost is approximately £6 per acre.

A rotation which is generally accepted is 30 to 35 years for Monterey pine and from 40 to 50 years for the other species. It is generally considered that about 10 per cent of the area of each plantation will be devoted to roads, breaks, and rides. Firebreaks and major access breaks vary from 66 feet to 500 feet in width, whilst the minor roads are from 25 feet to 50 feet wide. In the design of large schemes cognizance is taken of the need for reserving land for saw-mills, logging roads, and other operating needs. In New Zealand the construction of the forest roads has reached a fine art, and the largest caterpillar tractors with heavy mogul graders are now generally used for this work. The top soils are stripped off, thus exposing the mineral soils and thus minimising vegetable growth on the roads and breaks. A highly developed and efficient system of fire prevention communication is now standard in the larger New Zealand areas, involving the use of fire look-out towers and telephone lines, with strategically located tool caches and motor units for emergency work. Naturally in Australia the same degree of refinement is not yet in evidence, but substantial strides are being made along these lines.

Referring to the quality of the wood produced, much could be written on this subject but it is sufficient to say that the general quality will compare favorably with the grades milled from natural second growth in the United States, and more than favorably with wood goods produced in Scandinavian countries.

Technical Control

Forest technicians direct practically all the afforestation operations in Australasia, but the conduct of the field work is largely in the hands of locally trained officers. Higher forest education has been provided by the University of New Zealand, by the Australian Forestry School at Canberra, and by a Ranger School in Victoria. Public administrative policy is to progressively provide trained personnel for all of the respective state services, but it would be at least 25 years before this has been completely effected.

Observations

Afforestation with exotic softwoods in Australasia is now rapidly reaching a critical stage in its history; the first and easiest chapter to write is now completed, and in two or three years the planting of exotic conifers will be more or less stabilized with the establishment of about 1,000,000 acres. A tempered forecast indicates that within 25 years the man-made forests should be able to supply practically all of the coniferous softwood needs of Australasia and still leave a large balance of wood substance as raw material for the manufacture of cellulose products. The great urge to plant exotic conifers is now petering out, and the needs of forest management, silviculture, protection, and utilization are looming strongly on the horizon. Rapid growth is now bringing serious thinning problems and simultaneously troubles with "fire, chermes, beetles, and virus diseases." The forester has yet a long way to go silviculturally in solving the reactions of large masses of exotic pure stands to natural and human influences. The development of public and industrial afforestation on such a spectacular scale during a period of 17 years has so distinctly overshadowed programs of orderly regimentation of the indigenous forests that moneys urgently required for their betterment have been diverted to softwood projects. However, there are now evidences that those responsible for the administration of the indigenous forest wealth are beginning to take a more vital interest in this more important phase of forestry in Australasia. The subjection of the native forest resources to sound silvicultural control is the most important forest question at the present time in Australasia, and the development of a wider public appreciation of these relatively neglected resources is urgently required.

BRIEFER ARTICLES AND NOTES

Threat to Ohio Forestry Department Averted

In accord with established policy the Society of American Foresters has again exerted its influence to preserve the stability of a state forestry service. This time it was Ohio, where a bill was being pushed in the state legislature that would take the forest department from under the control of the State Agricultural Experiment Station and make it a political football. A statement in opposition was prepared by President Chapman and released by the Executive Secretary's office to all the leading newspapers in the state. Letters since received from foresters and other citizens of Ohio give evidence that this action, supplementing similar protests from other interested groups and individuals, played its part in killing the pernicious bill in committee. The Society's statement follows.

Franklin Reed,
Managing Editor.

Washington, D. C.—The proposed reorganization of the State Forestry Department of Ohio threatens seriously to impair the efficiency of forestry work in Ohio. The Society of American Foresters, the national organization of professional foresters of 2,400 members, urges that H.B. No. 379 be defeated for the following reasons:

This bill would wipe out the organization which was created in 1906 and has functioned with increasing efficiency for 28 years. The existing law gives the direction of forestry work in Ohio to a state forester appointed by the board of control of the State Agricultural Experiment Station at Wooster. Under its operation, the department has been completely free from political influences or overturns. The State Forester, Edmund Secrest, first entered state service in 1906 and since 1910 or for 24 years has directed all state forestry activities. Ohio now owns 7 state forests of 52,000 acres, 12 forest parks of 4,800 acres, is giving intensive fire protection to an area of over 1,000,000 acres, has distributed 25,000,000 trees for forest planting, and has greatly aided in the restoration of 2,800,000 acres of farm woodlots which are the main dependence of the State for forest products. Mr. Secrest is widely known and respected by foresters throughout the United States, and has built up an efficient force of assistants serving wholly on merit.

This organization cannot survive the proposed change, by which the entire executive responsibility of forestry work, including farm woodlots, is taken from the Experiment Station control and placed in the hands of a single conservation commissioner who is to take over the position and duties of state forester and is to be appointed by the Governor of whatever political party is in control at the time. Forestry work in order to be successful must be directed and conducted by trained technical men who are retained on the basis of efficiency and merit, and who can develop and follow up policies of land management, fire organization, and tree growth not for four years, but for many decades.

Ohio has reason to be proud of the progress made by its forestry department. This progress will continue if its citi-

zens support the present non-political system of organization under the Board of Control of the Experiment Station, a plan which has worked equally well in Maryland and Texas. House Bill No. 379 should be defeated.

Wallace Announces Merger of All Soil Erosion Work Under H. H. Bennett

To unify all soil erosion control activities of the federal government, Secretary of Agriculture Henry A. Wallace issued an order establishing a separate soil erosion unit in the Department of Agriculture. Carrying out the purposes of the Secertary's order, Under Secretary R. G. Tugwell at once undertook the task of consolidating the various departmental units working in this field.

The base of the new organization will be the Soil Erosion Service which has just been transferred to the Department of Agriculture from the Department of the Interior; this transfer was authorized by the Public Works Board at the request of the President.

All investigational, service, and control projects on erosion, heretofore handled by the Bureaus of Chemistry and Soils, Agricultural Engineering, and Plant Industry and the supervision of C.C.C. erosion-control work now under direction of the Forest Service, will be transferred on April 1 to the new unit.

H. H. Bennett will head the consolidated activities. Mr. Bennett has been in charge of the Soil Erosion Service since it was organized, and previously was in charge of soil erosion investigations of the Bureau of Chemistry and Soils.

Research will continue to be conducted at ten field stations, located in regions of different soil types, into the soil, plant, and engineering aspects of the cause and methods of controlling erosion. Using the facts developed by this research, large-scale demonstrations will be continued in various parts of the country.

Research primarily discovers how erosion may be controlled most effectively and economically. These results are translated into action by farmers themselves and by the Soil Erosion Service which is demonstrating effective methods of land conservation in forty erosion control projects in 32 states.

Ranging in size from 50,000 to 16,000-000 acres each, these projects cover representative watersheds in the major agricultural sections where erosion has become a critical problem.

Within each project, a completely balanced program of erosion control is being carried out in close coöperation with farmers and land owners of the area. Every known method of control, including both vegetative and mechanical measures, is applied to the land in accordance with its needs and adaptabilities. Work done within these representative areas constitutes a practical demonstration of land conservation methods most adaptable in the general region typified by the project-area.

Heintzleman to Have Charge of N.R.A. Conservation Work

The National Industrial Recovery Board authorized the establishment on March 1 of a new position entitled Deputy Administrator for Forest Conservation, in Division I, Basic Materials, of the National Recovery Administration. The purpose is to strengthen the participation of N.R.A. in the forest conservation activities under Article X of the Code for the Lumber and Timber Products Industries.

The new position makes no change in the existing general scheme of administration of Article X. The organized timber industries, through the Code Authority and its subordinate agencies throughout the country, administer the conservation measures under the general direction of the N.R.A. Heretofore one Deputy Administrator has handled all phases of the Lumber Code work, but henceforth the forest conservation work will be handled by the new Deputy and independently of the industrial activities. The two Deputies have co-equal authority and report separately to the Division Administrator.

The Deputy Administrator for Forest Conservation has full responsibility for seeing that the purposes underlying Article X are adequately accomplished by the Code agencies. He will consider proposals for changes in the Article, hold hearings at the request of interested parties on controversial subjects, investigate complaints, and make field inspections to determine the degree of compliance on the ground with the established policies and rules. By agreement between N.R.A. and the Forest Service, the latter will, on request of the Deputy, give advice on technical matters and make official inspections to obtain information for his use.

The Deputy will act as a liaison officer between the Code conservation agencies, the public forestry organizations, and the forest schools in Code conservation activities. He will arrange for joint studies of technical forestry problems which confront the Code foresters and for joint campaigns of education among operators in the application of the forest practice rules of the Code. He will also act as advisor in conservation matters to other Divisions of the N.R.A. having charge of codes which deal with forest products.

B. F. Heintzleman has been appointed to the new position. He is a native of Pennsylvania, a graduate of Mont Alto and Yale Forest School, and has had many years of experience in the Forest Service. He has specialized in forest management and was long connected with the timber sales branch of the Service in the Pacific Northwest and Alaska. During the past year he has been in charge of the coöperative work which the Forest Service is doing with the Code conservation agencies.

The establishment of this high position in its organization indicates that N.R.A. is fully aware of the great public interest involved in the application of the forestry measures provided for by Article X. It also indicates that N.R.A. does not contemplate a departure from the principle of self-government by the industry in the forest conservation field, but does intend to give the work closer direction as well as to arrange for better federal coöperation.

Central States Forestry Congress

Sidney D. Waldon of Detroit has been named as President of the Central States Forestry Congress for the year 1935, with George S. McIntire of the Michigan Department of Conservation as Secretary. The annual meeting of the Congress has been scheduled for June 19, 20, and 21 with Houghton Lake, Mich., as headquarters. This is the sixth meeting of the Congress, previous meetings having been held in Indiana, Ohio, Kentucky, Illinois, and Tenenssee. There will be three evening meetings starting on Wednesday, June 19, with the two following days devoted entirely to field trips.

Houghton Lake is located in the center of a region where many conservation activities are now under way. Follow-

ing the logging of the pine stands, for which northern Michigan was once famous, most of the area was burned over, proved unsuitable for agriculture, and very largely reverted to state ownership through the non-payment of taxes. These tax-reverted lands have been organized into state forests and game refuges, several of which will be visited by those attending the Congress. Fire control, nursery work, commercial and experimental plantations, cultural operations, and game and fish management work, including stream and lake improvement, are among the activities that will be inspected, together with two state parks.

The officers of the Congress are being assisted in arranging for the meeting by the Board of Directors for Michigan. These include P. J. Hoffmaster, Director of the State Department of Conservation; P. A. Herbert, Head of the Department of Forestry at Michigan State College; and S. T. Dana, Dean of the School of Forestry and Conservation at the University of Michigan. This is the first meeting of the Congress to be held in the so-called "wild land" section of the region and a large attendance is anticipated. In addition to the papers which will be presented at the evening sessions of the Congress, plans provide for a radio broadcast to be given over a national hook-up on Friday noon, June 21.

Pennsylvania Forest Tax Law Declared Unconstitutional

Pennsylvania in 1913 enacted a forest tax law setting up "auxiliary forest reserves," under which the "surface land" was to be valued at one dollar and then taxed on that value at the local rate, like other property. A yield of 10 per cent was imposed on the stumpage to be cut from such reserves.

Now, after twenty years, in a case of the Borough of Langhorne Manor et al. v. Commissioners of Buck County et al. the law was declared unconstitutional, because it was construed to violate Article IX, Sections 1 and 2, of the state constitution requiring a uniform system of taxation.

On the basis of this decision the Department of Forest and Waters must not only refuse all future applications but must notify all forest land owners who have classified land under the law in the past that their contracts are null and void.

Figures as of November 1, 1931, show that 42,186 acres had been classified under the law, or approximately 0.4 per cent of the privately owned forest land. Hence while this court action will work a hardship on a few owners, it does not affect the status of the bulk of the privately owned forest land in the state.

P. A. Herbert,
Michigan State College.

Business Meeting, Michigan Association of Municipal, County and Public Utility Foresters

President Carl Fenner read a communication from Charles F. Irish, President of the American Society of Arborists, in regard to the condition of the Dutch elm disease, and also read another communication from George Collingwood, Forester for the American Forestry Association, in regard to an appropriation for fighting Dutch elm disease. It was moved by Mr. E. A. Gallup, Superintendent of Parks, at Ann Arbor, that this association fill out one of Mr. Irish's petitions and send this to the proper authorities. The motion was carried.

President Fenner, early in the day, appointed the following nominating com-

mittee: George D. Blair,[1] H. Lee Bancroft, Carl Martin. The committee reported out two men for each position, except the secretary-treasurer. The following were elected to office, for the 1935 fiscal year: President, E. A. Gallup, Superintendent of Parks, Ann Arbor, Michigan; Vice President, C. L. Frankenfield, Detroit-Edison Company, Birmingham, Michigan; Secretary-Treasurer, Karl Dressel,[1] Michigan State College; Executive Committee—E. C. Eckert, Michigan State Highway Department, Plymouth; Carl Fenner, Assistant City Forester, Lansing; C. E. Smith, Superintendent of Parks and Boulevards, Detroit, Michigan. Motion was made, and carried to send a resolution to Dr. Haber, State Emergency Relief Director, in regard to more supervision and care in the cleaning and trimming of parks and roadsides by relief labor. President Carl Fenner appointed the following summer meeting committee: Chairman, L. C. Palmer,[1] Forester for the Kent County Road Commission; Carl Mulder, Kent County Road Commission; Clark Wilkinson, Michigan Bell Telephone, Grand Rapids; Dan Henry, Michigan State Highway Department, Grand Rapids, Michigan.

Should Study Future Market for Trees

"Before we proceed much further in our practice of growing and planting trees and the rehabilitation of our forest resources we should look very carefully into the uses for which the principal species will be needed as well as into the problems involved in their successful propagation, maintenance and economical harvesting," says Professor Raymand J. Hoyle of the New York State College of Forestry, Syracuse, N. Y.

"This would seem to be the logical way of approaching the forestry problem in this country. In other words, the utilization of forest products is the key to the situation as to what trees should be favored and produced. Heretofore the great urge to restore our forest areas, protect watersheds and set to work idle acres which have been rapidly increasing in recent years due to farm abandonment has greatly influenced the forestry outlook This accounts for the fact that since the planting of forest trees began in this country coniferous species have been used almost universally. Such use has been correct in reforesting poor soils. Careful study of the markets for wood in the State of New York and in other eastern states has shown, however, with increasing clearness the imporance of raising and harvesting hardwood trees and the manufacture of hardwood products. These species require fair to good forest soils for proper development.

"The first question asked by every interested woodlot owner in the State of New York is 'what can I do with my woodlot; where can I sell my trees and how am I going to get out of my forest properties the largest profit?' All of these questions are answered by the solution of problems in utilization which, of course, includes marketing. Perhaps we have had the cart before the horse in forestry. We have progressed in knowledge of the methods of improving our woodlots by skillful cutting but have not given enough attention to the problems of utilization. Based upon research, what are the markets today and what are the market tendencies for the future?"

[1]Junior Member, Society of American Foresters.

Timber Connectors[1]

These devices for securing stronger and more rigid timber-framed structures have achieved three new construction highs recently.

(1) The largest derrick substructure on record has just been built in Texas of timber-connector construction. This foundation structure is 16 feet from the ground level to the drilling floor and 36 feet square at the base which supports a 136-foot derrick.

(2) The timber-connector-built Dolan Creek arch bridge on the Pacific Highway, 50 miles south of Monterey, California, has a clear span of 180 feet between springing lines and a height above stream level of approximately 110 feet. Materials for this bridge were fabricated at or near the site by P.W.A. labor, and erection was completed in considerably less time than is ordinarily required for concrete arch bridges of similar size.

(3) A 320-foot all-wood radio broadcasting tower has just been completed at Richmond, Virginia, for Station WRVA. All connections in the tower were made with split ring connectors.

Frank Cartwright,
National Lumber Mfrs. Asso.

The Gnawing of Metal Tree Tags by Rodents

A recent remeasurement of cut-over growth plots in Clark County, Ind., brought to light an unusual destruction of metal tree tags by rodents. The greater portion of the damage was confined to tagged trees in areas of young sapling growth, composed primarily of scarlet oak, black oak, and hickories. Many tags were completely torn from the copper nails with which they were attached to the trees at breast height. The nails themselves were left intact. In a few instances only a portion of the tag was gnawed.

As near as can be determined, this gnawing is the work of the northern red squirrel (*Sciurus hudsonicus*) and related forms. Although no direct evidence pointed to this species as causing the damage, identification made by comparing the dentition of mounted specimens with the distinct teeth marks left on the aluminum tags was highly incriminating. The identification was made with the assistance of Dr. J. W. Price of the Zoology Department at Ohio State University.

Similar destruction of aluminum tags by rodents has been reported by L. I. Barrett, Associate Silviculturist, stationed with the Appalachian Forest Experiment Station. On the Bent Creek Experimental Forest and on experimental plots in north Georgia, Barrett determined the gnawing of aluminum tags to be the work of the gray squirrel [*Sciurus carolinensis carolinensus* (*Gmelin*)]. Identification by direct evidence was lacking, but a comparison of the width of teeth marks on tags with the dentition of dead squirrels

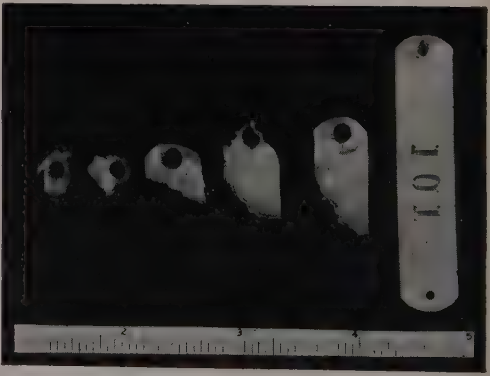

Fig. 1.—Aluminum tree tags gnawed by red squirrels on the Clark County State Forest, Henryville, Indiana. November, 1934.

[1]See Progress in Promoting the Use of Timber Connectors. Jour. of For. Vol 32: 8, 826-829.

was made. This diagnosis was checked and approved by T. D. Burleigh, the Biological Survey Collaborator at the Appalachian Forest Experiment Station of the Forest Service.

JOHN G. KUENZEL,
Central States Forest Experiment Station, U. S. Forest Service.

RESOLUTION ON SOUTHERN HARDWOOD FOREST RESEARCH[1]

WHEREAS, Hardwood timber products having an average value of more than one hundred million dollars per year are produced in southern states, and

WHEREAS, more than fifty million acres of forest land in the South are better suited to the production of hardwood timber than for any other purpose, and,

WHEREAS, the production, transportation and utilization of hardwood timber products provides employment for more than one hundred thousand families and is a major means of support for hundreds of communities, as well as an important source of wealth in every southern state, and,

WHEREAS, adequate future production of hardwood products from the privately owned forest lands of the South, through regrowth, requires more definite information on methods of managing cut-over hardwood lands for profit, as well as on methods of reducing waste and securing most economical utilization of hardwood timber, and,

WHEREAS, adequate funds for research in southern hardwoods have not been made available by Congress, although authorization for such research is contained in the McSweeny-McNary Forest Research Act of 1928,

THEREFORE, BE IT RESOLVED, that we, the Board of Directors of the Hardwood Manufacturers Institute, in annual meeting assembled at New Orleans, La., on March 12, 1935, and representing a large proportion of the hardwood lumber producers of the South, do hereby urge our representatives in Congress to use their best efforts toward providing, in the next appropriation bill for the Department of Agriculture, sufficient funds to undertake a broad program of research in the growth and utilization of southern hardwood timber through the Southern Forest Experiment Station and the Forest Products Laboratory of the Forest Service, and

BE IT FURTHER RESOLVED, that a copy of this resolution be forwarded to each Senator and Representative, with a request that he give earnest consideration to the urgent need for an adequate program of southern hardwood research.

GERMINATING KENTUCKY COFFEE TREE

Kentucky Coffee Tree, *Gymnocladus dioicus* (Linnaeus) Koch, is a species of hardwood well known to local woodsmen throughout the Central Hardwood Region for its hard, durable, deep red wood. Because the species is always found in mixture or in small groves on good moist soil, it has never attracted the enthusiastic attention of foresters and as a result very little is known concerning its silvicultural behavior. In connection with the establishment of an experimental forest at Ohio State University, the author had occasion to grow seedlings of this species in the University forestry nursery.

Previous experience had indicated that seeds of this species failed to germinate satisfactorily within a period of two years, even after stratification. Conse-

[1]Passed by the Hardwood Manufacturers Institute, at its annual meeting, New Orleans, La., March 12, 1935.

quently tests were conducted to determine whether an acid treatment would reduce the heavy, waxy seed coat and the horny albumen surrounding the seed coat sufficiently to make it permeable to moisture.

Seeds were collected from 25- to 30-year old trees in the University woods on April 10, 1934. The pods were easily shaken from the trees and the seeds were immediately extracted by hand.

Three hundred and fifty such seeds were collected and divided into six groups. All seeds were soaked in water at room temperature for 24 hours, after which the following treatment was given. One group of fifty seeds was used as a check, with no treatment except the soaking in water. Another set of fifty was rubbed on a file until the inner horny albumen coat, which was found to be highly hygroscopic, was exposed. The other four sets of fifty each were soaked in concentrated sulphuric acid for 5, 10, 30, and 120 minutes, respectively.

After the seeds were washed in water to remove the remaining acid, they were placed in sterilized flats containing pure sand, after which the surface of the sand was mulched with acid peat. Germination began in three days, but the plumules did not push above the surface of the soil until the fourteenth day after treatment. Table 1 demonstrates the progress of the germination and the relative efficacy of the sulphuric acid treatment.

At the end of thirty days the treated and scarified seeds which had not germinated were found to have rotted, and the test was discontinued. To further substantiate the effect of the acid treatment, the seeds used as a check, of which only 4 per cent germinated, were separated from the soil and subjected to acid for two hours. A germination of 84 per cent was obtained from these seeds.

Although scarification of the seeds gives comparable results, the method is more laborious and costly; and when germination takes place the hypocotyl of the seed becomes curled up in the seed coat to such an extent that some of the hypocotyls of germinated seeds never reached the soil.

To summarize, it is suggested that when contemplating the growing of Kentucky coffee tree seedlings the seeds be stored dry in cold storage over winter and given a one- to two-hour treatment in concentrated sulphuric acid after soaking in water for about twenty-four hours. Seedlings grown during 1934 in the nursery at Ohio State University from seed treated in this fashion have a high survival and have attained in one year heights of from 6 to 12 inches and diameters of .2 to .5 inches.

E. G. Wiesehuegel,
Ohio State University.

Losses of Black Locust Planting Stock in Storage

Observations made in connection with erosion control planting studies carried on near Holly Springs, Marshall County,

Table 1

GERMINATION OF KENTUCKY COFFEE TREE SEED CROP OF 1933

Number of days after sowing	Per cent of seeds germinated						
	Check	Scarified seed	H_2SO_4 treatment for 5 min.	10 min.	30 min.	120 min.
15	0	6	4	6	6	6
20	2	58	16	30	24	48
25	4	78	30	40	38	82
30	4	80	30	44	40	86

Miss., indicate that black locust planting stock, and perhaps that of other broad-leaved species as well, should be heeled in in sand, rather than in the heavier silt and clay loam soils, to prevent losses in storage.

Storage in sand is particularly essential when the stock cannot be planted before late March or early April.[1] When stored in heavy soils, which tend to remain water logged and in a poorly drained condition after heavy rains, a rank growth of molds often forms on the buried portions of the seedlings and the roots decay within a few days. The bark and cambium around and above the root collar also decompose, often to such an extent as to completely girdle the seedling. Although poor drainage seems to be chiefly responsible, the condition appears to be aggravated by warm, humid weather.

Losses from this source, although noted during previous planting seasons, were unusually severe during the spring of 1934. On March 28, black locust stock was transferred from nursery to planting area and heeled in in shallow trenches dug in a silty clay soil. The soil was in a saturated condition, and a few days later the weather turned warm. Damage to the stock occurred sometime between April 3 and April 6, and was first noted on the latter date. Fully 50 per cent of the trees had to be thrown away; and the remainder, although not visibly damaged, were reduced in quality to such an extent as to affect adversely all subsequent tests in which this class of stock was used. This is brought out by observations made about one month later.

Random trees were examined on areas planted April 3, and on the same or adjacent sites planted on April 6 and 7, after molding and root decay had occurred. The comparison was between trees planted by the same crew and method and differing only as to planting date. Of the Grade 1 trees 18 per cent of those planted April 3 had been killed back to the ground, as compared with 36 per cent of those planted four days later. Grade 2 stock suffered much more severely. Ninety-one per cent of those planted April 6 had killed back, while only 36 per cent of those planted April 3, a few days before marked injury occurred, had suffered similarly. General observations of other trees planted on the later dates or soon thereafter revealed that a comparatively large number had been killed back. Although it is not uncommon for black locust to die back when planted on such adverse sites and at a similar late date, it is most probable that damaged planting stock was to a considerable extent responsible for the unusually large number of trees so affected.

Heeling in stock in loose sand, a foot or more in depth, is apparently good insurance against such losses, since sand is well aerated and provides adequate sub-drainage. On no occasion during the past three planting seasons has planting stock suffered noticeable injury of this type when stored in sand.

H. G. Meginnis,
Southern For. Exp. Sta.,
U. S. Forest Service.

Increment Tables for the Oak Type

Annual and periodic growth for oak forests is given in Tables 1 and 2. These data were computed from data previously published.[1] Site index is for average

[1]These dates mark the end of the planting season in the locality, since black locust and other species begin leafing out at about this time.

[1]McIntyre, A. C. 1933. Growth and Yield in Oak Forest of Pennsylvania. Pa. Agric. Exp. Sta. Bull. 283.

dominant heights at 50 years of age. The growth rate of the 5 oaks and associated species varies within rather narrow limits. Variations in stand composition are usually compensating and these data are applicable to nearly all normal oak forests of the northern Appalachian and southern Allegheny regions.

TABLE 1

MEAN ANNUAL INCREMENT OF OAK FORESTS. PENNSYLVANIA, 1934

A. C. McIntyre — T. A. Liefeld, K. R. Ziebarth

Total age years	Site index 30	40	50	60	70
	(Cubic feet entire stem)				
10				17	22
20		25	33	43	56
30	17	26	35	46	59
40	18	27	36	47	60
50	18	27	36	47	61
60	18	27	36	47	61
70	19	27	36	47	60
80	18	26	36	46	60
90	18	26	35	46	59
100	17	25	35	45	58
	Merchantable cubic feet 4 inch top				
20				18	29
30		7	20	36	48
40	5	15	28	43	56
50	9	19	32	46	59
60	12	22	34	47	61
70	14	24	36	48	61
80	15	25	36	48	61
90	16	26	37	48	61
100	17	27	38	48	60
	Board feet: International ¼ inch rule				
30				37	87
40			32	75	140
50		24	58	110	186
60	12	40	81	140	221
70	22	54	100	161	244
80	31	67	115	177	263
90	38	77	127	191	277
100	45	85	138	203	290

TABLE 2

PERIODIC ANNUAL INCREMENT IN OAK FORESTS. PENNSYLVANIA, 1934

A. C. McIntyre — T. A. Liefeld, K. R. Ziebarth

Age period years	Site index 30	40	50	60	70
	(Cubic feet entire stem)				
10 to 20				70	90
20 30	19	29	39	50	65
30 40	19	28	38	49	63
40 50	18	28	37	48	63
50 60	18	27	36	47	60
60 70	17	26	35	45	58
70 80	16	24	33	42	55
80 90	16	23	32	41	52
90 100	15	23	31	39	50
	Merchantable cubic feet 4 inch top				
20 to 30				73	86
30 40		39	53	63	78
40 50	29	37	49	58	73
50 60	27	36	45	55	69
60 70	26	35	44	52	63
70 80	25	35	43	50	61
80 90	24	34	42	48	60
90 100	24	34	42	47	60
	Board feet: International ¼ inch rule				
30 to 40				190	300
40 50			160	250	370
50 60		120	200	290	395
60 70	80	140	210	295	385
70 80	92	155	220	295	390
80 90	97	155	225	300	395
90 100	110	160	235	310	405

A. C. McINTYRE.

DEAR MR. REED:

My compliments on the March issue of the JOURNAL, proofs of which I have this moment received. It is one of the best issues of your magazine I have ever seen—and you get out good ones, too.

I have given some coverage to the papers, but I believe there is still plenty of material to supply me with one or more good news items on the question of forest administration in the South. I shall try to get out these in a day or two.

FRANK THONE,
Science Service.

REVIEWS

Pot Culture Tests of Forest Soil Fertility, with Observations on the Effect of Varied Solar Radiation and Nutrient Supply on the Growth and Nitrogen Content of Scots and White Pine Seedlings. By Harold L. Mitchell. *The Black Rock Forest, Cornwall-on-the-Hudson, N. Y., Bull. No. 5. 1934.*

This latest contribution from the Black Rock Forest presents in an unusually satisfying form a technique by which site qualities may be evaluated on a quantitative scale from the available nutrients in the soil. An actual application is made to four sites, ridge, good and poor middle slopes, and cove, using the available nitrogen as the basis. Moreover, the scale promises to be sufficiently standardized and sensitive that it can be used as a measure of soil improvement resulting from silvicultural treatment of the repeatedly culled and burned stands of sprout hardwoods of the Hudson Highlands and surrounding region.

A satisfactory quantitative evaluation of site quality in terms of soil properties which may thus be utilized as an absolute scale applicable to wide areas is a material but not the only contribution in this Bulletin. It also provides a review of recent developments in plant and soil experimentation heretofore not much used in forestry, and exemplifies their value.

Scots and white pine seedlings were used as indicators, first in sand cultures with inorganic nutrient solutions, and then in soils from the different sites to which solutions containing different combinations of nutrients were added. Adjustments for differences in seed weight were applied to the weights of one-year-old seedlings. Maximum yields of both species were found at an optimum nitrogen supply of 300 p.p.m., beyond which the yields were depressed. Like yield, internal N concentration attained a maximum of 3.2 per cent at 300 p.p.m. and was used as the direct measure of availability of the external supply both in sand cultures and in soils.

Deficient N was indicated by a yellow-green needle color, and deficient phosphorus by a purple color of the lower needles of white pine seedlings.

Root-shoot ratios and root development varied inversely as the N concentration. This relationship was less clear in natural soils, where mycorrhizae developed more abundantly on the seedlings grown in the less fertile media.

Increase from 50 per cent to 100 per cent solar radiation gave increased yields only when the N supply was above 55 p.p.m. Total N absorption was little affected. Hence, percentage N content was higher in the seedlings grown in 50 per cent light. Variations between different years in total radiation for the growing season were reflected in growth.

Using the calculated average relation between N supply and N per cent content of white pine seedlings grown in sand cultures as a standard scale, the nitrogen fertility equivalents of the soils of the four natural sites, expressed as percentages of the 300 p.p.m. optimum, were 9.9 for the ridge, 13.5 for the mid-slope (good), 15.9 for the mid-slope (poor), and 24.1 for the cove. All of the soils showed phosphorus deficiency.

Comment by P. R. Gast, an extensive bibliography of titles, mostly from the sciences related to forestry, and appendices containing the details of data and method and descriptions of the stands and soils complete the bulletin.

At various points in the text, it appears that the evaluation of fertility on the basis of available nitrogen makes the poor middle slope superior to the good. No explanation or comment is forthcoming until the end of a paragraph in Appendix 3, where it is mentioned that nitrogen is not the limiting constituent on the poor middle slope, and that further tests are being made to ascertain whether there are deficiencies in Ca, P, or K which might be the cause of the poor growth. The obvious inconsistency would justify an earlier explanation. In fact, for most foresters the descriptions of forest and soils of Appendix 3 would be helpful in the body of the text, as an aid in visualizing the conditions to which application of the methods is made, even if some repetition from earlier bulletins of the Black Rock Forest series were involved.

In the analysis of the changes and interrelations of yield or of nitrogen, use is made of formulae of the Mitscherlich type, modified by the addition of a depression factor to express the descending portions of the curves beyond the optima. The close correspondence of experimental and calculated trends is demonstrated by the high values of the correlation indexes and low values of the standard errors. The nice coördination between experimental technique and mathematical analysis and testing of results is one of the noteworthy features of this bulletin, which in these as in other respects is a valuable contribution to the scientific foundation of forestry.

J. Kittredge, Jr.,
University of California.

Floods and Accelerated Erosion in Northern Utah. *U. S. Dept. of Agric., Misc. Pub. No. 196.*

Floods from the Wasatch Mountains near Salt Lake City, Utah, during recent years exceed any during the 20,000 years or more since ancient Lake Bonneville, according to geologic evidence presented in this bulletin. The evidence further points to rapid accumulation of water, even from moderate rains, on critical parts of the watersheds, where the vegetation has been seriously depleted and modified through overgrazing and fire. The rainfall, instead of percolating into the plant and soil mantle as it originally did, now rushes off the slopes, eroding soil, gouging out stream channels, and producing devastating floods.

These studies have served as a basis for developing an important part of the C.C.C. program of restoration of vegetative cover for erosion and flood control.

W. R. Chapline,
U. S. Forest Service.

Reflektioner rorandeden planterade skogens utveckling. (Reflections On the Development of Planted Forests.) By E. Nyblom. *Skogen 21 (23):522-524, 1934.*

Greater volume production at a young age was attained in central Sweden with planted stands of Scotch pine than with natural. The trees were more branchy and form class lower in the planted stand, but by pruning a few crop trees the quality should be much improved. Including the yield from the first three thinnings, the plantations have earned well over 4 per cent.

Henry I Baldwin,
Caroline A. Fox Research and Demonstration Forest.

Une Relique de la Sapinière Méditerranéenne. Le Mont Babor: Monographie de l'Abies numidica Lann. Étude de Sylviculture, de Dendrologie et d'Entomologie Forestière. (A Remnant of the Mediterranean Fir Type. Mt. Babor: a monograph of Abies numidica Lann. A study in silviculture, dendrology, and forest entomology.) By A. Barbey. *Paris. 1934.*

M. Barbey introduces his very interesting article on the forests of Mt. Babor with a detailed resumé of the firs of the Mediterranean region, their range and relationships. He concludes that the forests of the Mt. Babor region have not been destroyed, like those of Greece and Asia Minor, because of their isolation and favorable climatic conditions.

On leaving the cultivated region in ascending the mountain from the north one first comes to a rather abused stand of cedar. Fire has left the older trees in poor condition, but a ban upon grazing has saved much young growth. The cedar is badly stunted and deformed by snow, ice, and high winds.

One then enters a zone of green oak, mixed with cedar and in pure stand. The cedars in the mixture are particularly well developed, due to the seedbed prepared for them by the oak. A number of other species enter into the mixture in lesser numbers, including several maples. Snow and winds prevent this type from growing to the summit, which reaches an altitude of 6,510 feet. There is comparatively little undergrowth. *Abies numidica*, which is first met at an altitude of 5,360 feet, continues to the top. It reaches a large size and attains ages of from 250 to 300 years. It apparently seeds well even at that altitude, but the export of seed, the poor seedbed conditions, and grazing keep the reproduction to a minimum.

The bulletin also contains a brief account of the geology of the region, of the rare plants and fauna noted, and a brief description of the insects found attacking the wood, bark, seed, and leaves of the *Abies numidica*.

M. Barbey concludes his article with an assurance that the unique forests of Mt. Babor will be properly protected and conserved; and he offers a suggestion of how it may be done by preparing grazing grounds elsewhere, so that the natives shall not be forced to graze their flocks in the forest.

The pamphlet is splendidly turned out, on good paper with beautiful illustrations. We might very well look up to it as a model toward which to strive in this country.

E. G. Cheyney,
University of Minnesota.

Reversion of Forest Land for Taxes Increasing in the South. By Ronald B. Craig. *Southern Forest Experiment Station, U. S. Forest Service, Occasional Paper No. 32. July, 1934.*

Tax delinquency has become a very serious problem in the Southeast. Approximately twelve million acres, or 8 per cent of the total forest land in that region, have reverted to the state for the nonpayment of taxes; and the depression of the last few years, with an ever mounting tax rate, bids fair to increase materially the area of "New Public Domain."

The situation, according to the author of this four-page publication, is alarming not only to those interested in the economic stability of the lumber business but to those interested in other industry and in the financing of local government.

P. A. Herbert,
Michigan State College.

Management of American Forests. By Donald M. Matthews. *McGraw-Hill Book Co., New York, 495 pp. 1935. Price $5.00.*

This is the most recent addition to the excellent series of textbooks now being issued under the editorship of Professor Walter Mulford. Opportunely it comes at a time when the principles of sustained yield forest management are receiving more serious attention on the part of foresters and lumbermen than at any time in the past. The author of the new book accomplishes what many considered to be impossible, namely, without lessening its value for classroom instruction, he has written a concise treatise in language that lumbermen without technical forestry training will understand and which will tell them the things they want to know about sustained yield forest management.

Professor Matthews may or may not have had a dual usage in mind when writing his text, but a review of the book would be only half complete if it failed to recognize the potentialities of this dual use. The writer has had the unusual privilege of using a manuscript copy of this text in instruction of a class in forest management. The reaction of the students to the new text has been most favorable, and the writer is convinced that a large part of this favorable reaction must be credited to the matter of fact, practical way in which the subject is treated. The presentation which this writer judges would appeal most to the hard-headed business man also seems to be the presentation which appeals most strongly to the student. The timberland owner also will appreciate a treatise on forest management which does not urge him for sentimental, academic or for sketchy, so-called business reasons to engage in sustained yield management of his properties; he will find here clear, concise statements impartially presenting both liquidation and sustained yield facts in understandable dollars and cents language. Unquestionably, much of the failure of foresters to convince lumbermen of the desirability of sustained yield can be attributed to the inability of foresters in general to speak in terms of real monetary values.

The book is arranged in two parts. The first half of the book deals with the fundamental phases of tree growth, stocking, rotation, growing stock, regulation of cut, and application of these principles to forest properties. The second half of the book treats of the financial aspects of forest management with discussions on such basic subjects as the nature of capital and income in forest business, valuation of forest land, timber and stumpage, the financial aspects of destructive logging versus sustained yield management, forest taxation, forest insurance, and damage appraisals. Tables of compound interest, derivation of interest formulae, an outline showing in detail the financial organization of a property for sustained yield management and a bibliography are given in an appendix. Loblolly pine is used throughout for illustrative examples, presumably because the southern pine region offers attractive possibilities for sustained yield management and many useful data are available on stocking and costs of conversion.

Some phases of forest management probably will appear to be inadequately treated to specialists in these fields. The chapter on taxation which very largely embodies Prof. Matthews' own ideas on this debatable subject may seem imperfect. The same might be said of certain other aspects of the financial management section. It should be remembered, however, that this is not designed as an exhaustive discussion of any one subject

but as a text-book for use in schoolroom instruction where time is at a premium. Many also may be irritated at the frequent and almost exclusive references to Roth but this fault, if it be one, may be forgiven the author who was a student of Professor Roth and has dedicated his book to that author of the first American text on forest management.

The book is well made and has practically no typographical errors. Some of the tables are in two parts, occasionally on two separate pages, and would be more understandable if printed as units.

As a teacher of forest management the text appeals to this writer because its style and manner of presentation is clear and direct; because the author of the book never forgets his audience or overestimates its ability to follow the detail of his ideas; because he does not talk down to his readers; because, without going too fast, he plunges directly into his subject; because he sticks to simple fundamentals and does not try to discuss all sides of all things; because he discusses only the management of American forests under American conditions; because he somehow, and without protestation, gets across the idea that he knows what he is talking about.

Richard E. McArdle,
Idaho School of Forestry.

Forest Mensuration. By Donald Bruce and F. X. Schumacher. *Pp. 360, Figs. 97, illustrative tables 52. McGraw-Hill Book Company, New York, 1935. $3.50.*

Forest Mensuration, by Bruce and Schumacher, strives to bring about a revolution in the treatment of this subject by laying a scientific foundation of statistical methods on which may be erected a superstructure of procedures. To this end a modification of the definition of forest mensuration is given, namely, "The science of forest measurements, or forest mensuration as it is also called, is concerned with the determination of diameters, heights, or volumes either of standing timber or of products cut therefrom, such as saw logs or cordwood, and the determination or prediction of rates of growth." The introduction of the word "science" is well planned and this concept is followed assiduously. There is no mention of the word art and the treatment of the various subjects omits its consideration.

The book is divided into four parts and virtually every point that is discussed is illustrated by an example from the field of forestry. Part one, entitled Direct Measurement, covers eleven per cent of the publication, is readily interpretable and is well illustrated with cuts. It discusses the usual forest mensuration instruments, their fields of use in measuring diameters and heights, the computation of cubic volume from the resulting measurements, the measurement of the cord and the measurement of age.

Part two, entitled Direct Estimate by Sampling, covers twenty-one per cent of the book. This part might have been called "Statistics." The treatment is thorough and in places recondite. This portion is most commendable for the excellent description of the normal curve of error, for its uses and examples drawn from portions of practical forestry problems, and also for the adherence to the conventional symbols of statistics. The method of presenting the fundamentals of simple sampling is unique. Four chapters deal with examples which depend upon one of these conditions before the rules are simply and concisely stated. Two interpretations of the standard error are discussed in this section—a third is presented later. There was an opportunity here to untangle terms that have been

bothersome to students of statistical applications in the field of forestry. This section of the book is of further interest because, in addition to the examples concurrent with the explanation of principles, a whole chapter is devoted to additional forest mensurational examples illustrating the statistical measures of the previous chapters. One chapter headed Sampling gives the scientific fundamentals of cruising without mentioning the term. With the recent developments in this branch, a good-sized book could be written on the many procedures in vogue at the present time but that is not the purpose of this publication.

Part three, entitled Indirect Estimate Based on One or More Independent Variables, covers forty-six per cent of the book. This section starts with a chapter on the Effectiveness of Free-hand Curves. The key word is "effectiveness" as the statistical measures for the applicability of curves are emphasized. The contents of this section may be grouped as follows: 27 pages on the method of least squares, 42 pages on alinement charts, 67 pages on free-hand curves and anamorphosis, and 28 pages almost devoid of statistical interpretations. Almost two-thirds of the 28 pages is allotted to the subject of log rules and scaling while the remaining one-third illustrates the use of the proper variables through examples on tree form and volume tables. The inclusion of the method of least squares in a book on forest mensuration is indicative of the foresight and keenness of the authors. It may appear that too large a proportion of these pages is devoted to graphic representation. This, however, is not the case as the statistical tests of applicability are stressed rather than the procedure of curve drawing. Those chapters dealing with alinement charts are well written and the subject is developed carefully and thoroughly. The chapter on log rules is particularly interesting as it forcibly presents the problem of over run in making the deductions for cull in scaling.

Part four, Predicton of Growth and Yield, occupies but sixteen per cent of the book. The comparatively small space allotted this tremendously important subject may be explained by the fact that all of the statistical processes are described in previous chapters, thus making it only necessary to refer to examples in the major portions of the book. This section starts with a chapter on Cylical Variation and Growth of Timber. Such a discussion further attests the precience of the authors. The primary portion of this section deals with the Growth of Even-Aged Stands. This chapter is unusually well presented, clears up many of the points that have given trouble to the uninitiated and should be of material help to those engaged in making yield tables for even-aged stands. It is, however, to be regretted that a more thorough discussion of what constitutes a normal stand and how normality can be recognized in the field is not included. The last chapter, Growth of All-Aged Stands, is introduced with a practical view of what should be considered an even-aged stand. No method of yield prediction for all-aged stands entirely acceptable to the authors is advocated, although several are discussed. It is to be hoped that, with such a strong foundation as is laid in the earlier chapters, a satisfactory solution of this problem will be developed.

This independent and pioneering publication deals with the *science* of forest mensuration rather than the art. The book is hampered by an inadequate index and depends largely for its successful application as a text upon the ability of the instructor to explain, interpret and integrate the examples into projects and techniques. The book is copiously and well illustrated with problems and fig-

ures, has practice exercises at the conclusion of most of the chapters, suggests many practical problems that are yet unsolved, lays a firm foundation for fundamental research in forest mensuration, and brings under one cover the various statistical measures and their uses in forestry problems. The book is a definite contribution to the science of forest mensuration.

JOHN C. SAMMI,
N. Y. State College of Forestry.

This book is one of the American Forestry series of which Walter Mulford is consulting editor. Books of this series are intended for the college student, the practicing forester, and men in the forest industries. It is expected that the series will eventually cover the entire field of forestry.

The authors' justification for this book is that mensurational training has not been satisfactory because the students were not taught the fundamental technique and use of tools in mensurational work. Rather they learned as the carpenter's apprentice, first by building something simple and later as experience is gained build the more difficult things. The authors propose that first and above all the students shall have a basic and full understanding of mensuration tools and technique so that they can meet and accomplish any job that comes up even though it be different from any example they studied in college. In their own words: "For these reasons this book has been written. The conventional order has been abandoned and instead of the familiar sequence of scaling, estimating, and growth studies an arrangement has been sought which will facilitate the progressive acquisition of the ability to handle the tools of mensuration."

Chapman's and Demeritt's recent book on mensuration stressed the "economic approach," whereas the authors of this book were apparently content to stick closely to methodology, technique, and tools.

Recent books on mensuration have dipped into statistics a little, but seemingly with some misgivings as to whether the data really belonged in their text. This book leaves no doubt as to the authors' intention and belief, for it is chock-full of statistical methods and applications. This is certainly a constructive move and should go a long way in testing out and determining the place of statistics in forestry work. It is a delight to a forester to find a text on statistics that uses forestry data for examples. Most other texts on the subject have used data far removed from forestry, such as speed of automobiles, dextrose decomposition, etc., and as a result it has been difficult to really see the application in our own field.

The book is divided into four major parts:

Part I, Direct Measurement, contains five chapters and deals largely with mensurational tools and their use.

Part II, Direct Estimate by Sampling, contains five chapters also and plunges immediately into statistical consideration and analysis of forestry data and the determination of adequate sampling, measurement of errors, and the amount of data required to give a certain degree of accuracy. The discussion on the use of averages is particularly pertinent. To those who have to get their statistics by digging them out on their own this section is very acceptable and for college students it should be equally satisfactory.

Part III, Indirect Estimate Based on One or More Independent Variables, contains eleven chapters and makes up nearly half the entire text. This section covers intensively methods of analyzing data, such as graphs, alignment charts, least

squares, relationship of variables, etc. There are many terms not generally found in forestry literature of the past. It will require careful study to assimilate the material presented in this section. Relatively new terminology will have to be mastered, such as amputated graphs, anamorphosis, alienation coefficient, etc. Fortunately forestry data are used throughout, which gives to the statistical methods a feeling of reality and practicalness. Both of the authors are statistical enthusiasts, but they point out that statistical methods are not fool-proof and may not give a warning of erroneous use. For example, on page 186 in discussing least squares they say ". . . . the method is applicable only where the form of the equation is known or may reasonably be used as a hypothesis. It should be reiterated that no warning will be given if a wrong assumption in this respect is made. . . . . since most of the relations with which forestry is concerned have no known form this method is little used in practical work. . . . . In scientific work, however, the method is invaluable as a means of testing how well an equation of a type that is deduced from theoretical considerations fits actual data."

Part IV, Prediction of Growth and Yield, has four chapters. One is devoted to stressing the need for considering time and cyclical variations in growth studies, another to growth of the tree, a third to growth of even-aged stands, and the last to growth of all aged stands.

The authors close their book with the constructive thought that mensuration methodology is not static or fully developed and that continued progress is highly desirable and may be expected.

The book is well bound and plainly printed on good paper; the figures are clear cuts of reasonable size with easily read titles and headings. Exercises and problems are given at the end of each chapter. There is no bibliography. It is a welcome addition to forestry literature.

R. D. Garver,
Forest Products Laboratory.

Theory and Practice of Silviculture. By Frederick S. Baker. *McGraw-Hill Book Co., New York. 502 p., 87 figs. 1934. Price $5.*

This book is the second volume in the new American Forestry Series recently launched by the McGraw-Hill Book Co. under the consulting editorship of Professor Walter Mulford. The author justly claims a new and somewhat unique method of approach, viewpoint, and manner of presentation followed in the book, which is ample justification for the undertaking. The author states in the Preface that, to attain his objective of presenting the full field of knowledge upon which the well-informed forester should draw for the formulation of his silvicultural theory and practice, he has included in one book the biological foundations of silviculture and the practice of silviculture. The reviewer seriously doubts whether this could be covered adequately in several volumes. If the author is taken literally, as we suspect he does not so desire, the general fields of physics, chemistry, zoology, geology, mathematics, and the more specialized ones of plant anatomy, plant physiology, genetics, plant ecology, dendrology, meteorology or climatology, soil science, plane surveying, forest mensuration, forest entomology, and forest pathology would have to be summarized. True enough the author delves into a few of these subjects, particularly plant physiology, plant ecology, and genetics, but any of the other subjects are treated only incidentally. Be this as it may the author most appropriately insists on predicating a rational silviculture upon a firm physio-

logical basis with which no broad-minded, deep-thinking silviculturist will disagree.

The book is composed of 5 parts. Part I, dealing with plant physiology, contains chapters on forest genetics, the water cycle, the carbon cycle, the nitrogen and mineral cycles, growth of trees, reproduction of the forest, and injury, disease, and death of forest trees. Part II treats the following subjects in forest ecology: forest types and sites, form and composition of stands, density of stands, tolerance, the theory of succession, and crown classification. Part III has the unusual title Systematized Silvicultural Experience and briefly treats silvicultural systems, thinnings, cleanings, and improvement cuttings. The fact that pruning now practiced in the East under certain conditions is omitted makes it evident that the book was written primarily for western conditions. Part IV is called The Forest Itself as a Source of Silvicultural Knowledge and contains one chapter on field studies in silviculture. It is very interesting but would perhaps be more appropriate in a manual or handbook on silvicultural research. Part V, although headed Silvicultural Literature, really contains two chapters entitled Applied Silviculture in which there is condensed in 50 pages material gleaned from the literature on the chief forest regions of the United States. There is need for an entire book on regional silviculture.

The reviewer is glad to see emphasis placed on the physiological basis of silviculture, but regrets to see this emphasis at the expense of an undesirable condensation of the material on silvicultural systems, stand treatment, and regional silviculture. With the importance placed upon the physiological approach, it is surprising to find that soil, which should receive a thorough treatment under a physiological approach, is considered only incidentally.

After all the main cause for disagreement with the author is perhaps pedagogical rather than biological. This textbook, intended primarily for undergraduates, apparently presupposes that the student has had little or no basic work in biological subjects, particularly plant physiology and plant ecology, prior to entering upon the study of silviculture. This is indeed unfortunate and the reviewer feels that it is a direct reflection upon the four-year curricula of many of our undergraduate schools of forestry into which the usual run of forestry courses are crammed together with the other subjects required by the particular college. The results should be obvious. Many essential basic courses in fundamental subjects are crowded out of the curriculum and forestry instructors often find themselves having to teach a smattering of basic subject matter along with the forestry subjects and the student is often poorly trained all along the line. Would it not be better for the basic subjects such as plant physiology and plant ecology to be taught thoroughly by specialists in these fields rather than by foresters, who are sufficiently "jacks-of-all-trades" without having to teach these subjects in addition to forestry?

The author has earnestly endeavored to make the treatment simple and understandable—a very commendable motive. However, numerous places are found where a change in diction is suggested by the context. For example, such expressions as "thirst of the cell sap," "have enough sense," "can the seedling hope to exist," "fight for water," and "acting without foresight" are distinctly teleological and should be avoided. On the other hand pedantic expressions such as "to speak anthropomorphically" and "heated adiabatically" occur. Occasionally one finds a reference incorrectly cited or cited but not included in the bibliography. Some of the common discrep-

ancies in diction to which foresters are more or less addicted, such as "stood" for "withstood," "secured" for "obtained," "accelerated growth" for "increased growth," "bleached zone" (of soil) for "leached zone," "forest school" for "school of forestry," "on the national forests" for "in the national forests," are encountered. Anyone of several different ways of expressing the thought would be much better than to say "nature of the beast," which is used by the author.

In spite of the reviewer's reservations regarding the book, he finds that it contains very useful and interestingly written discussions and summaries on many silvicultural subjects, supported by good, although not always adequate, citations to the literature. The prophesy is made that, while not adapted for use by graduate students or undergraduates who are adequately prepared in the subjects basic to silviculture, the book will probably find considerable use in some undergraduate schools of forestry.

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In this book the author has chosen a new manner of presentation of silvicultural facts and relationships. Accordingly the work is divided into five main parts as follows: I. Plant Physiology in Silviculture; II. Forest Ecology; III. Systematized Silvicultural Experience; IV. The Forest as a Source of Silvicultural Knowledge; and V. Silvicultural Literature.

Part I, containing seven chapters, 153 pages, begins with a consideration of forest genetics and environment and next, follows the water cycle of the tree from its source in the soil through the structures of the tree until transpired by the leaves. The various relationships of water to the plant as well as climatic, seasonal, and site influences affecting the water supply and sap movement are expounded in detail. The carbon cycle is similarly treated, including the requirements of the photosynthetic process, its duration and the removal of elaborated products. The nutrition phase continues with a discussion of the nitrogen and mineral cycles. Sources of nitrogen and agencies taking part in its formation are discussed in detail. The last three chapters of Part I are concerned with the growth of trees, reproduction of the forest, and factors causing injury, disease, and death of forest trees. These topics are treated here from the physiological viewpoint. Growth is discussed in the light of assimilation, stored foods together with environmental factors affecting top, root, and stem growth and the top-root ratio. Reproduction is considered in the light of factors influencing seed production, dissemination, germination, root systems, and the effect of moisture and shade. The plant physiology section of this book introduces a fund of information valuable as a background in developing the silvicultural conditions desired.

Part II, containing six chapters totaling 92 pages, deals with the subject of Forest Ecology. The basic ideas of ecology as they relate to forest types and sites are illustrated by a presentation of climatic zones or provinces and their typical plant classifications. Site quality is discussed and defined, methods of site classification are described and examples given. The form of stands is discussed both from the standpoint of even and mixed ages, and pure and mixed species. Advantages and disadvantages of each are included. The effect of density of stands is shown in relation to volume growth, merchantable volume, and wood quality, introducing the subject of tolerance, the discussion of which involves

many of the physiological factors and relationships, and shows their true connection with the development of the forest. The theory of plant succession is elaborated leading to the recognition of the climax, degeneration and a second succession. The subject of crown classification appears rather isolated at the close of the ecological discussions. Altogether, the Section on Forest Ecology presents many of the details of factors closely associated with silvicultural practice. Their consideration in this part of the book simplifies the later presentation of silvicultural practices.

Part III, Systematized Silvicultural Experience, consists of four chapters, aggregating 110 pages. In this part is found the kernel of the silvicultural text. It presents and classifies silvicultural methods long practiced in Europe and discusses their applicability or lack of it to American conditions. The silvicultural systems described include basic clear cutting systems, basic seed tree systems, basic shelter wood systems, and basic selection systems. Deviations from the standard basic systems are called atypical systems. The economic selection system often termed "selective logging" is considered as a transition system. The text further indicates that American silvicultural practice has consisted more of the application of economics than of silviculture and points out the need of more flexible logging operations before we can hope for the development of silvicultural practice along European lines.

Coppice forests are treated briefly, reference being made to dormant buds, stump sprouts, and root-collar sprouts; the effect of season of cutting, form of stump and rotation age are considered, followed by the application of the coppice system to different forest regions in the United States. Considerable attention is given to an analysis of silvicultural systems with a discussion of many variables involved in cutting as well as many of the physiological and ecological relationships such as seed production and dissemination; silvicultural control of germination and establishment as influenced by light, soil moisture, temperature, and competition; and the growth of residual stands. The avowed purpose of this detailed discussion is to present information upon which trends toward more intensive silvicultural practice in the United States may be based.

Intermediate cuttings and thinnings conclude Part III and are dealt with in a rather classical manner. The standard methods, thinning from below, thinning from above, and the selection thinning method are given due recognition. A fourth method, the "loose" thinning system is mentioned also.

Part IV, The Forest Itself as a Source of Silvicultural Knowledge, constitutes one chapter of 23 pages. This chapter emphasizes the knowledge obtainable from careful observation of forest conditions, especially with reference to past silvicultural treatment. Problems answerable from the forest itself are divided into three classes, namely, the determination of seed production, problems in forest reproduction, and common problems of forest growth. The first considers the production of seed by individual trees or on an acre basis; the second takes up methods of sampling for determining the amount and distribution of reproduction on a forest area; while the third is concerned with the forecasting of the growth of trees and stands. The chapter ends with a warning about the use of inaccurate figures.

Part V, Silvicultural Literature, two chapters containing 52 pages, lists the sources of applied silviculture in the United States by regions and discusses the application of silvicultural practice

to typical stands and forest types.

The book contains 50 tables and is illustrated by 87 figures (graphs and drawings, no half tones). There is an appendix containing:

1. A list of common names used with scientific equivalents.

2. Bibliography, 23 pages, 510 titles.

3. Index, 14 pages.

The book is very comprehensive in its scope, the subject matter is presented logically and clearly. Physiological, ecological, and silvicultural relationships, too often lost sight of in practice, are knit together and emphasied throughout the text. Evidently the author recognizes the pressing need of improved silvicultural methods in this country and has endeavored to present his subject in such a way that the essential information will be easily accessible to the practicing forester. For the advanced student this work provides a valuable reference text.

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U. S. Forest Service.

Finland's Flottareförenings Årsbok III 1934. (Yearbook of Finland's River Driving Association.) *(22nd year.) Helsingfors, 1934.*

This is a well illustrated booklet of some 200 pages, with articles in both Swedish and Finnish. Detailed descriptions of arrangements for bundling logs, of charcoal gas generators for driving tug boats, tractors, etc., and of flumes and other appliances are given, with working drawings as well as photographs. A section is devoted to statistics of log driving in 1933-34 in Finland.

Henry I. Baldwin,
Caroline A. Fox Research and
Demonstration Forest.